MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

Vol. XLIII JANUARY-FEBRUARY No. 1

CONTENTS

PUBLISHED BIMONTHLY FOR

THE NEW YORK BOTANICAL GARDEN

AT PRINCE AND LEMON STS., LANCASTER, PA.

Entered as second-class matter April 30, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.

MYCOLOGIA

Published by

THE NEW YORK BOTANICAL GARDEN

IN COLLABORATION WITH THE

MYCOLOGICAL SOCIETY OF AMERICA

GEORGE LORENZO ZUNDEL

1885–1950

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XLIII JANUARY–FEBRUARY, 1951 NO. 1

GEORGE LORENZO ZUNDEL, 1885–1950

JOHN A. STEVENSON

George Lorenzo Zundel was professionally a plant pathologist but always with definite mycological leanings and it was a matter of keen regret to him that circumstances never made it possible for him to devote full time and energy to the study of fungi and the smut fungi in particular. He was forced to develop this interest as a side-line, a hobby as it were, to be followed only on the relatively few evenings or week-ends when an active career as an extension plant pathologist permitted. Nevertheless, as his bibliography and his herbarium of smut fungi will demonstrate, he succeeded in making his mark in the field of taxonomic mycology.

Dr. Zundel was born December 23, 1885 in Brigham City, Utah, and died at Logan in the same state on March 10, 1950. His early life was spent in Brigham City and on the nearby farm of his grandfather where at thrashing time he had his first experiences with the smut fungi. Following graduation from high school he entered Brigham Young College at Logan, finishing the course in general science and transferring to the Utah State Agricultural College in 1909, from which institution he graduated with the B.S. degree in 1911.

Following a year as instructor in botany and horticulture at the latter institution and a second year as teacher of agriculture at Brigham City high school, he entered Cornell University in September 1913. Here he majored in plant pathology, taking his Master's degree in 1915. For the following two years he was

[MYCOLOGIA for November–December (42: 683–816) was issued January 11, 1951]

assistant professor of biology at Brigham Young College, beginning his work in plant pathology in the summer of 1916 as a scientific aide of the Bureau of Plant Industry, studying the relation of soil fungi to potato diseases.

With the coming of World War I, Dr. Zundel was assigned to smut control work at the Agricultural Experiment Station at Pullman, Washington, taking part in the war emergency food production program. He was soon appointed extension plant pathologist for the State of Washington in cooperation with the United States Department of Agriculture, an arrangement discontinued in 1920, at which time he became a full time state employee. It was during this period that his interest in the taxonomy of the smut fungi was aroused, much of his time having been devoted to developing cereal smut control programs.

This interest finally led him to enter the graduate school of Yale University in 1926, where under the direction of G. P. Clinton he gained the Ph.D. degree with a dissertation on the Ustilaginales of the World. During this time he also was an assistant to Dr. Clinton in mycology and plant pathology and took a leading part in preparing a revision of Clinton's treatment of the Ustilaginales for North American Flora.

Following this experience he became assistant professor of plant pathology in the extension service of Pennsylvania State College in July 1928, where he spent the remainder of his active career. Here his work was largely with fruit diseases and he was for many years a popular and effective worker in the field. In 1946 he was transferred as Associate Professor to the staff operating agricultural correspondence courses. Continued ill health brought about his retirement in September 1949, at which time he returned to his native state.

Most of his papers on the taxonomy of the smut fungi appeared during his years at Pennsylvania State College, including comprehensive studies of the smut fungi of Pennsylvania, of new and rare North and South American species, of the Ustilaginales of South Africa and India, and a series of papers on the Ustilaginales of the World. Many species and one genus were described as new in the course of his studies. His major work, a complete account of the Ustilaginales of the World, the subject of his dissertation, un-

fortunately remains in manuscript form. His extensive herbarium, including types of his new species, and many critical and rare collections from all parts of the world, forms part of the Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering at Beltsville, Maryland.

Dr. Zundel was a member of several scientific organizations during his life-time, among which were the Amer. Assoc. for the Advancement of Science (Fellow), the Mycological Society of America (charter member), the American Phytopathological Society, the Botanical Society of America and the British Mycological Society. He married Rose Mae Bell of Logan, Utah, in 1910. Mrs. Zundel and a son, Robert Clayburn, survive him. A selected bibliography follows.

BIBLIOGRAPHY

1. Smuts of oats and barley. Wash. Agr. Exp. Sta. Extension Service, Ser. 1, No. 43, 4 pp., illus. 1918.
2. Wheat smut control. Proc. Ann. Convention Wash. Grain Growers, Shippers and Millers Assoc. **13**: 34–39. 1918.
3. (With B. F. Dana.) Head smut of corn and sorghum. Wash. Agr. Exp. Sta. Popular Bull. 119, 8 pp., illus. 1920.
4. (With B. F. Dana.) A new corn smut in Washington. Phytopath. **10**: 328–330, illus. 1920.
5. Some Ustilagineae of the state of Washington. Mycologia **12**: 275–281. 1920.
6. Smuts and rusts of northern Utah and southern Idaho. Mycologia **13**: 179–183. 1921.
7. (With F. D. Heald.) The control of cereal smuts in Washington. Wash. Agr. Exp. Sta. Bull. **62**: 1–21, illus. 1921.
8. The effects of treatment for bunt on the germination of wheat. Phytopath. **11**: 469–484, illus. 1921.
9. Control of apple scab. Wash. Agr. Exp. Sta. Extension Bull. **99**: 1–7, illus. 1923.
10. (With F. D. Heald and L. W. Boyle.) The dusting of wheat and oats for smut. Phytopath. **13**: 171–183, illus. 1923.
11. Control of blight diseases of the potato. Wash. Agr. Exp. Sta. Extension Bull. **104**: 1–7, illus. 1923.
12. Mosaic and related diseases of the potato. Wash. Agr. Exp. Sta. Extension Bull. **105**: 1–8, illus. 1923.
13. Harvesting and storing potatoes to prevent disease. Wash. Agr. Exp. Sta. Extension Bull. **111**: 1–11, illus. 1924.
14. Potato wilt diseases. Wash. Agr. Exp. Sta. Extension Bull. **113**: 1–6. 1924.
15. (With Horace Sykes.) Grain fire prevention. Wash. Agr. Exp. Sta. Extension Bull. **115**: 1–8. 1924.
16. Notes on the Ustilagineae of Washington. Mycologia **18**: 87–89. 1926.

17. Notes on Pennsylvania Ustilaginales. I. Mycologia **22**: 97–100. 1930.
18. Monographic studies on the Ustilaginales attacking Andropogon. Mycologia **22**: 125–158. 1930.
19. Raspberry disease control. Pa. Agr. Exp. Sta. Circ. **133**: 1–20, illus. 1930.
20. New or unusual symptoms of virus diseases of raspberries. Phytopath. **21**: 755–757, illus. 1931.
21. Notes on new species of Ustilaginales. Mycologia **23**: 296–299. 1931.
22. The Ustilaginales of Pennsylvania. Proc. Pa. Acad. Sci. **7**: 122–129 (reprint repaged 1–8). 1933.
23. New and rare North and South American Ustilaginales. Mycologia **25**: 349–355. 1933.
24. Miscellaneous notes on the Ustilaginales. Mycologia **29**: 583–591, illus. 1937.
25. The Ustilaginales of South Africa. Bothalia **3**: 283–330. 1938.
26. Raspberry disease control. Proc. Maryland Hort. Soc. **1937**: 70–75 (reprint pp. 1–6). 1938.
27. (With G. P. Clinton.) Notes on some Ustilaginales from India. Mycologia **30**: 280–281. 1938.
28. George Perkins Clinton, 1867–1937. Mycologia **30**: 481–493. Portrait. 1938.
29. A new smut from Southern Chile. Mycologia **30**: 679–680. 1938.
30. Studies on the Ustilaginales of the World. Mycologia **31**: 572–589. 1939.
32. Studies on the Ustilaginales of the World. II. Mycologia **34**: 123–127. 1045. 1939.
32. Studies on the Ustilaginales of the World. II. Mycologia **34**: 123–127. 1942.
33. (With A. B. Massey.) *Sorghastrum*, host of an undescribed smut. Phytopath. **32**: 544–546. 1942.
34. Notes on the Ustilaginales of the World. III. Mycologia **35**: 164–184. 1943.
35. Bramble diseases. Pa. Agr. Exp. Sta. Circ. **250**: 1–16, illus. 1943. (Revised pp. 1–17, illus. 1947.)
36. Notes on the Ustilaginales of the World. IV. Mycologia **36**: 400–412. 1944.
37. Notes on a proposed new genus and four new species of the Ustilaginales. Mycologia **37**: 370–373. 1945.
38. A change in generic name. Mycologia **37**: 795–796. 1945.

INCREASING POTENCIES OF ENZYMES PRODUCED BY ASPERGILLUS NIGER [1]

E. A. Weaver and T. C. Cordon

Work at the Northern Regional Research Laboratory has established the usefulness of *Aspergillus niger* in the production of amylases (Le Mense et al. (**3**)). In adapting these methods to production of amylases on potato substratum, it became evident that certain modifications were required. Calcium carbonate in the potato medium significantly decreased enzyme potencies, as was found also by Tsuchiya et al. (**6**) of the Northern Regional Research Laboratory. *A. niger* grew vigorously on potato substratum, but filtrates of fermentations showing extremely abundant mycelium after short incubation periods had low enzyme potencies. Work was therefore initiated to obviate this condition on the theories that: (a) Young active mycelium liberates minimum quantities of enzymes into solution, and conversely, dead mycelium liberates maximum quantities of enzymes; and (b) comminution of the mycelium increases enzyme potencies by releasing cell contents.

Aspergillus niger NRRL No. 330 was grown on 6 per cent whole potato flour with an inoculum of three million spores per ml. of medium and incubated at 30° C. on a reciprocal shaker. Enzyme potencies of all cultures whether treated or untreated were determined on the supernatant liquid obtained after centrifuging. Starch conversion was determined by the ferricyanide method reported by Erb, Wisthoff and Jacobs (**2**) except that sulfuric acid was omitted from the recommended buffer solution. Maltase was determined by a copper reduction method, essentially that of Somogyi (**5**), supplied by Dr. Henry M. Tsuchiya of the Northern Regional Research Laboratory, which measures milligrams of maltose hydrolyzed per ml. of culture per hour.

[1] Report of a study made under the Research and Marketing Act of 1946 at the Eastern Regional Research Laboratory, one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

Many of the methods used for preparing enzymes from yeasts and bacteria were tried. These methods are reviewed by Umbreit et al. (**7**), Werkman and Wood (**8**), and Bernhauer and Knobloch (**1**). Except for the homogenizer described by Potter and Elvehjem (**4**), none of these methods gave satisfactory increases in enzyme potencies. Our objective of obtaining a method which could be adapted to commercial use was of paramount importance in evaluating the usefulness of the above methods. Several mechanical methods of extracting amylases from *A. niger* mycelium are given in table I. A modified Logeman hand homogenizer gave

TABLE I

EFFICIENCY OF DIFFERENT MECHANICAL METHODS FOR EXTRACTING AMYLASES FROM *Aspergillus niger* MYCELIUM

Sample	Treatment*	Starch conversion		Maltase	
		%	% increase	†	% increase
1	None	51.16	—	13.4	—
	A	53.34	4.3	12.5	0
	B	57.00	11.4	32.6	143.1
2	None	22.50	—	5.3	—
	B	30.83	37.0	17.3	226.4
	C	27.58	22.6	7.3	37.1
	D	28.75	27.8	8.9	67.4

* A = Processed for 20 minutes at high speed in a water-cooled Waring Blendor.
B = Processed five times in a *modified* Logeman hand homogenizer.
C = Processed for 20 minutes in a Charlotte Colloid Mill, Model A, set at 0.001 inch.
D = Processed five times in the Logeman hand homogenizer.
† Milligrams of maltose hydrolyzed per ml. of culture per hour.

satisfactory increases in enzyme potencies and was selected for comminution of the mycelium over the other treatments investigated. This Logeman hand homogenizer was modified by grinding both pressure plates flat, increasing tension on the spring, placing rings on the piston and reinforcing the handle. It was estimated that this modified homogenizer comminuted the mycelium so that about 10 per cent was less than 10 microns long, whereas the other treatments mentioned in table I seldom produced hyphae less than 50 microns long. This action is coincident with the increased liberation of starch-converting enzymes and maltase over the other treatments of table I.

As shown in table II, comminuting different fermented potato media in the modified homogenizer consistently produced increased amylase potencies. Lack of pH control decreased enzyme potencies, which has been shown previously by Tsuchiya et al. (**6**). The pH of Samples 1 to 5 was not under adequate control. Good pH control was maintained throughout the incubation period for Samples 6 to 9. Enzyme potencies of samples held for longer incubation periods showed that starch-converting enzymes were liberated in good supply without comminution but maltase was still significantly increased by comminution.

TABLE II

INCREASE IN AMYLASE POTENCIES DUE TO COMMINUTION OF *Aspergillus niger* MYCELIUM

Sample	Incubation time, hours	pH >4.40 during incubation	Starch conversion, %			Maltase		
			Not com.*	Com.*	Increase	Not com.†	Com.†	% increase
1	17	No	—	—	—	0.4	6.6	1780.0
2	18	No	10.7	15.2	42.2	3.7	12.3	231.1
3	18	No	7.7	11.2	45.6	4.1	19.3	376.5
4	18	No	18.8	24.5	30.7	9.4	21.6	130.8
5	18	No	13.3	16.7	25.8	3.5	7.9	125.6
6	21	Yes	13.1	22.3	70.7	8.6	19.4	126.9
7	31	Yes	—	—	—	14.2	30.4	113.8
8	32	Yes	51.2	57.0	11.4	13.4	32.6	143.1
9	41	Yes	56.0	60.8	8.6	14.8	36.4	146.1

* Com. = comminuted, that is processed five times in the modified homogenizer.

† Milligrams of maltose hydrolyzed per ml. of culture per hour.

Killing the fungus with fungicides did not give a significant increase in maltase immediately but produced a significant increase in soluble maltase on storage (TABLE III). Storing the control (fermented medium, fungus not killed) in a refrigerator for extended periods of time did not produce an appreciable increase in maltase. Ammonium bifluoride was the best fungicide tried for killing the fungus. Merthiolate, as well as several other fungicides used, had inhibitory action on the maltase.

As shown in table III, comminution of the dead mycelium in a fermented medium produced significant increases in enzyme potency, even after storage of the dead mycelium for as long as 18 days. These studies indicate that the maltase enzyme system has

limited permeability to both the living and dead cell membranes, or that (a) maltase is merely occluded in the protoplasm and additional quantities are set free on release of protoplasm from the cell, or (b) maltase is bound to materials not permeable to the cell membrane, so that release of the cell protoplasm permits activity even though the maltase is bound to a constituent(s) of the protoplasm.

TABLE III

EFFECTS OF CHEMICAL AND MECHANICAL TREATMENTS OF *A. niger* MYCELIUM ON LIBERATION OF SOLUBLE MALTASE

Sample	Storage	Fungicide	Maltase values*		
			Not com.	Com.	% increase due to com.
1	A. 18 hrs. at 30° C.	None	18.1	—	—
	B. 18 hrs. at 30° C.	0.1% merthiolate	17.3	—	—
	AB. % increase due to fungicide		−4.4	—	—
	C. 14 days at 4° C.	None	18.5	22.5	21.9
	D. 14 days at 30° C.	0.1% merthiolate	23.9	27.1	13.5
	CD. % increase due to fungicide at 14 days		29.4	20.5	—
2	A. 72 hrs. at 30° C.	None	5.8	8.9	54.5
	B. 72 hrs. at 30° C.	0.1% ammonium bifluoride	7.3	17.3	138.0
	AB. % increase due to fungicide		26.4	94.7	—
	C. 18 days at 30° C.	0.1% ammonium bifluoride	10.3	20.4	98.8
	AC. % increase due to fungicide†		78.5	129.7	—

* Milligrams of maltose hydrolyzed per ml. of culture per hour.
† Based on results obtained in 2A.

These results direct attention to the important effect of pretreatment of the fermented medium on enzyme potencies. Methods which employ culture filtrates for determination of enzyme potency can supply misleading information on the potential quantities of enzymes in a fermented medium. By using a culture filtrate of a fermentation, it is possible to obtain results which indicate that a poor fermentation with a high proportion of dead mycelium has a higher concentration of enzymes than a vigorous fermentation with

a low proportion of dead mycelium. Actually, in absolute terms, the vigorous fermentation might have the higher enzyme content because of the greater quantity of mycelium. There is need of a simple, efficient means of releasing the entire cell contents of fungus mycelium without inactivation of the desired product. With such a method available, the efficiency of proposed industrial operations for the release of the enzyme could be more accurately evaluated.

It is believed that the mechanical and chemical treatments reported here for increasing the concentration of soluble enzymes from young, active mycelium release only a fractional quantity of the enzymes in the mycelium. Increased efficiency of comminution and more suitable fungicides are expected to give increased enzyme potencies. Proper comminution of the mycelium would provide both a killing action on the mycelium and slice the cell, liberating the cell contents.

Other methods of treating *A. niger* mycelium to increase enzyme potencies, such as plasmolysis, enzymolysis, and increasing cell membrane permeability, are being studied.

ACKNOWLEDGMENT

The writers wish to thank Margaret D. Walsh for assistance with much of the technical work.

EASTERN REGIONAL RESEARCH LABORATORY,
PHILADELPHIA 18, PENNSYLVANIA

LITERATURE CITED

1. **Bernhauer, Konrad, and Heinrich Knobloch.** Die methoden der Fermentforschung **2**: 1303–1325. G. Thieme, Leipzig. 1941.
2. **Erb, N. W., R. T. Wisthoff and W. L. Jacobs.** Factors affecting the production of amylase by *Aspergillus niger,* Strain NRRL 337, when grown in submerged culture. Jour. Bact. **55**: 813–821. 1948.
3. **Le Mense, E. H., J. Corman, J. M. Van Lanen and A. F. Langlykke.** Production of mold amylases in submerged culture. Jour. Bact. **54**: 149–159. 1947.
4. **Potter, V. R. and C. A. Elvehjem.** A modified method for the study of tissue oxidation. Jour. Biol. Chem. **114**: 495. 1936.
5. **Somogyi, Michael.** A new reagent for the determination of sugars. Jour. Biol. Chem. **160**: 61–68. 1945.

6. **Tsuchiya, H. M., J. Corman and H. J. Koepsell.** The production of fungal amylase by submerged culture. Soc. Am. Bact. Abst. of Papers. 49th General Meeting, p. 48. 1949.
7. **Umbreit, W. W., R. H. Burris and J. F. Stauffer.** Manometric techniques and related methods for the study of tissue metabolism. pp. 84–93. Burgess, Minneapolis. 1947.
8. **Werkman, C. H., and H. G. Wood.** Die Methoden der Fermentforschung **2**: 1191–1214. G. Thieme, Leipzig. 1941.

OBSERVATIONS ON THE INHIBITORY ACTION OF HYDROLYZED AGAR

WILLIAM J. ROBBINS AND ILDA MCVEIGH [1]

In the course of experiments on the nutrition of *Trichophyton mentagrophytes* it was observed that partially or completely hydrolyzed agar had an inhibitory effect on growth. Because agar is so commonly used in media for various types of organisms, it seemed desirable to investigate this effect further.

Preliminary experiments. Agar was melted in 0.05 *N* H_2SO_4, cooled, neutralized to approximately pH 6.0 with $Ba(OH)_2$ and the $BaSO_4$ removed. This preparation was added at the rate of 1.5 mg. per ml. to a medium containing mineral salts, dextrose, asparagine and 1.5 per cent unhydrolyzed agar. The medium was tubed, sterilized and inoculated with *Trichophyton mentagrophytes.* The pH of the medium was between 4.5 and 5.0. The fungus grew on this medium but growth was considerably less than on the medium to which no partially hydrolyzed agar was added.

Agar boiled 15 minutes with 0.05 *N* H_2SO_4, agar autoclaved 30 minutes with 0.05 *N* H_2SO_4 or autoclaved 20 minutes with 0.1 *N* H_2SO_4, and treated as above, completely inhibited the growth of *Trichophyton mentagrophytes.* The addition of an excess of $CaCO_3$ to the medium did not prevent the inhibitory effect of the hydrolyzed agar.

In further experiments it was found that 7.0 mg. of hydrolyzed agar per ml. of the basal agar medium completely prevented growth of the fungus. When 0.35 mg. of the hydrolyzed agar was added per ml. of the basal medium, a slight but evident inhibitory effect was observed.

Staphylococcus aureus. In serial dilution tests, approximately 1 mg. of hydrolyzed agar per ml. of beef broth completely inhibited the growth of *Staphylococcus aureus* (Heatley strain). Several samples of agar from different manufacturers gave similar results.

[1] Now Associate Professor of Biology, Vanderbilt University.

Preparations from various algae. Through the assistance of Miss Hannah Croasdale, a number of species of algae were collected at Woods Hole, Massachusetts, and dried. Ten grams of each alga in the air-dry condition were autoclaved for 20 minutes at 15 pounds pressure with 250 ml. of 0.1 *N* H_2SO_4. The hydrolysates were neutralized with $Ba(OH)_2$, the $BaSO_4$ removed, and the resulting solutions concentrated by evaporation to the equivalent of 12 per cent agar. Dry weights were determined for each hydrolysate at 100° C for 18 hours. The inhibitory activity was tested against *Staph. aureus* by serial dilution.

Negative results were obtained with the hydrolysates of *Enteromorpha intestinalis* (12.9 mg. per ml.), *Ulva lactuca* (29.1 mg. per ml.), *Ascophyllum nodosum* (44.3 mg. per ml.), *Chorda filum* (81.5 mg. per ml.), *Chordaria flagelliformis* (43.2 mg. per ml.), *Laminaria agardhii* (47.0 mg. per ml.), *Mesogloia divaricata* (26.4 mg. per ml.), *Sargassum filipenduli* (18.9 mg. per ml.), *Champia parvula* (28.1 mg. per ml.) and *Lomentaria baileyana* (20.9 mg. per ml.).

Complete inhibition of *Staph. aureus* after 24 hours incubation was observed with hydrolysates of *Fucus spiralis* at 2.5 mg. per ml., *Fucus vesiculosus* at 1.2 mg. per ml., *Agardhiella tenera* at 1.4 mg. per ml., *Ceramium rubrum* at 2.7 mg. per ml., *Chondria tenuissima* at 2.7 mg. per ml., *Chondrus crispus* at 3.2 mg. per ml. and *Polysiphonia variegata* at 3.5 mg. per ml. Hydrolyzed agar was effective in these tests at 1.4 mg. per ml.

Variability in algae. Hydrolysates of three samples of *Chondrus crispus* were prepared. The minimum concentrations of dry matter of the hydrolyzed samples necessary for the inhibition of *Staph. aureus* were as follows: *Chondrus crispus* from Maine coast, 1.7 mg. per ml.; from Woods Hole, 1.6 mg. per ml.; from S. B. Penick and Company, 0.5 mg. per ml. The minimum inhibitory concentration for the hydrolyzed products of the gum carrageenin, prepared from *Chondrus crispus,* was 1.4 mg. per ml. However, the hydrolysate of a collection of *Fucus vesiculosus* from Woods Hole gave complete inhibition of *Staph. aureus* at 1.2 mg. per ml. but for a sample collected on Long Island the minimum inhibitory concentration was 12.8 mg. per ml. The hydrolysate of a sample of *Ulva lactuca* from Woods Hole showed no activity at 29.1 mg.

per ml., but one collected on Long Island was active at 4.2 mg. per ml.

Tests on other types of material. The activity of hydrolyzed agar was compared with that of various chemical compounds and natural products treated with H_2SO_4 and $Ba(OH)_2$ in the same manner as described for agar. The minimum quantity necessary for the complete inhibition of *Staph. aureus* for a 24 hour incubation period was determined by serial dilution.

Negative results were obtained with mannitol at 125.3 mg. per ml., dextrose at 138.9 mg. per ml. and gum arabic at 127.5 mg. per ml. The minimum inhibitory amounts per ml. for other substances were as follows: bran, 17.6 mg.; sawdust (beech), 2.2 mg.; levulose, 8.6 mg.; gum traganth, 19.1 mg.; sucrose, 9.2 mg.; brown sugar, 10.0 mg.; d-lactose, 71.9 mg.; corn starch, 74.5 mg.; apple (dried), 51.4 mg.; 1 + arabinose, 28.9 mg.

TABLE I

MINIMUM CONCENTRATION IN MG. PER ML. OF HYDROLYSATES OF AGAR AND CHONDRUS CRISPUS FOR COMPLETE INHIBITION AFTER 24 HOURS

Bacterium	Agar hydrolysate	Hydrolysate of *Chondrus crispus*
Bacillus mycoides	2.8	1.2
Bacillus subtilis	11.2	9.6
Escherichia coli	5.6	4.8
Klebsiella pneumoniae	11.2	9.6
Mycobacterium smegma	11.2	19.2
Pseudomonas aeruginosa	5.6	4.6
Staphylococcus aureus	1.4	0.6

Furfuraldehyde at 1 mg. per ml. did not inhibit *Staph. aureus* as determined by the cup test; agar hydrolysates produced zones with a diameter of 20 to 25 mm. on the same plates. Furoic acid and tetra-hydrofuroic acid did not completely inhibit growth of *T. mentagrophytes* when added to an agar medium at the rate of 0.6 mg. per ml.

Bacterial spectrum. The minimum inhibitory concentrations in terms of dry matter per ml. of hydrolysates of agar and of *Chondrus crispus* were determined for a number of bacteria by serial dilution. The spectra for the two hydrolysates showed no essential differences; this suggests that the inhibitory substances in both hydrolysates were the same or similar (TABLE I).

Fungi. Some observations on the antifungal activity of hydrolysates of agar and of *Chondrus crispus* were made with the assistance of Dr. A. N. Hervey by serial dilution in a peptone medium at pH 6 (TABLE II). Spore suspensions were used as inoculum. *Trichophyton* was incubated at 30° C; the others at 25° C. The inhibitory action of the hydrolysates varied with the species of fungus. *Trichophyton, Chaetomium* and *Gliomastix* were the most susceptible under our conditions; *Aspergillus, Myrothecium, Penicillium* and *Phycomyces,* the most resistant.

TABLE II

MINIMUM CONCENTRATION IN MG. PER ML. OF HYDROLYSATES OF AGAR AND OF CHONDRUS CRISPUS FOR COMPLETE INHIBITION AFTER 24 AND 72 HOURS OF VARIOUS FUNGI TESTED IN SERIAL DILUTION (P = PARTIAL INHIBITION)

Fungus	Agar hydrolysate		Hydrolysate of *Chondrus crispus*	
	24 hrs.	72 hrs.	24 hrs.	72 hrs.
Aspergillus niger	>4.2	>4.2	>3.8	>3.8
Chaetomium globosum	2.1, 4.2p	4.2	1.9	3.8
Gliomastix convoluta	2.1	4.2	1.9	3.8
Memnoniella echinata	—	4.2p	—	>3.8
Myrothecium verrucaria	4.2, 8.4p	>4.2	3.8p	3.8p
Penicillium notatum	4.2	>4.2	3.8p	>3.8
Phycomyces Blakesleeanus	4.2	>4.2	3.8p	>3.8
Stemphylium consortiale	2.1	4.2	3.8	3.8p
Trichophyton mentagrophytes	—	2.1	—	3.8, 7.6p

Isolation of inhibitory material. We were not successful in concentrating the toxic material in hydrolyzed agar. Extraction of agar hydrolysates with chloroform, methyl isobutyl ketone and ethyl ether gave negative results. Agar hydrolysate was evaporated to a thick gummy mass and extracted with acetone. The active material was not concentrated in the acetone. Some of the gummy material was extracted with absolute ethanol and the residue remaining was then extracted with 80 per cent ethanol. No concentration of the antibacterial material was found in the alcohol fractions. The toxic material was not absorbed on charcoal (Norit A) or on kaolin from acid or neutral solution.

Stability of inhibitory material. Hydrolysates of agar maintained their activity unchanged for some weeks but some which

had been stored for a period of two years had lost about three-fourths of their activity when tested against *Staph. aureus*. Various observations suggested that drying the hydrolysates of agar or of *Chondrus crispus* even at 50° C resulted in considerable loss of activity. Concentration of the hydrolysates by heating at atmospheric pressure to one-fourth the original volume did not affect activity materially.

Discussion. Since agar is commonly used in laboratory practice it is important to recognize that toxic products may be formed by its hydrolysis. From this standpoint more information would be desirable on the effects of partially hydrolyzed material which is more likely to be found in media than the fully hydrolyzed product.

It is unfortunate that we were unable to concentrate the inhibitory material or materials from hydrolyzed agar. Their chemical nature and antibiotic activity in pure form would be of interest.

Summary. Agar hydrolyzed with 0.1 per cent sulfuric acid completely inhibited *Staphylococcus aureus* at approximately 1 mg. per ml. It was less effective on other bacteria and some fungi. Seven of seventeen species of algae yielded hydrolysates inhibitory for *Staph. aureus*. Efforts to concentrate or isolate the inhibitory material in agar hydrolysates were not successful.

DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY AND
NEW YORK BOTANICAL GARDEN

ACTIVITY OF THE ASPERGILLI ON CELLULOSE, CELLULOSE DERIVATIVES, AND WOOL

ELWYN T. REESE AND MARY H. DOWNING

Frequent reference is made in the literature to the activity of various organisms on different industrial materials. Usually the work has been done by individuals more intimately concerned with the nature of the degradation than with the identity of the organisms. Recently, three papers have been published in which the earlier works have been reviewed and new data presented. A wide range of organisms has been studied for ability to attack cellulose by White *et al.* (**6**), and by Marsh *et al.* (**2**). The relationship of the black Aspergilli to cellulose degradation has been studied in detail by White *et al.* (**8**). The identity of all the organisms employed in these investigations was thoroughly established in accordance with the monograph of Thom and Raper (**5**).

A large collection of microorganisms isolated from deteriorating materials is maintained in this laboratory. One objective of our research on this collection is the determination of the organisms which are active in the degradation of various materials employed by the Quartermaster Corps. A continuous testing program is under way in which all the organisms isolated from deteriorating materials are being evaluated for their activity. The present paper reports the results on cellulose and on autoclaved wool obtained from a study of 422 isolates belonging to the genus *Aspergillus*. Isolates, representative of each group, were examined microscopically. Any organism about which there was any question of proper identification was sent to Dr. K. B. Raper for confirmation.

The complex nature of cellulose degradation is becoming more apparent as experimental data accumulate. In an earlier report (**4**), it was shown that the ability to hydrolyze the 1,4 β-glucosidic linkages of the cellulose chain does not in itself determine whether an organism can attack cellulose, since many non-cellulolytic micro-

organisms possess the enzyme (Cx) carrying out that reaction. It was postulated that cellulolytic organisms possess an additional enzyme (C_1) capable of converting native cellulose into the form acted on by Cx. This enzyme (C_1) is lacking in non-cellulolytic organisms. The present paper considers both the ability of members of the Aspergilli to hydrolyze the 1,4 β linkage, and the ability to degrade cellulose.

EXPERIMENTAL

The method for testing the activity of all isolates was slightly modified from that previously used in this laboratory by White *et al.* (**6**). Cloth strips ravelled to a width of 1 inch and cut to a length of 3 inches, were placed into 20 × 150 mm. pyrex test tubes. A nine ml. aliquot of the following nutrient solution was added to each tube: yeast extract 0.01%; $MgSO_4 \cdot 7H_2O$, 0.03%; NH_4NO_3, 0.1%; M/100 potassium phosphate buffer pH 5.7; initial pH 6.3 ± 0.2. After sterilization and cooling, each tube was inoculated with 1 ml. of spore suspension. Incubation was at 30° C. for 2 weeks, at the end of which time the strips were examined for growth and harvested. After the usual conditioning treatment, tensile strength determinations were made by means of a Scott tester. Five replicates of the 3.3 oz. bleached cotton sheeting and four replicates of the wool charmeen were used. For our purpose, we consider as inactive those organisms which effect a loss in tensile strength of less than 15 per cent in two weeks. This is purely arbitrary and organisms which are weakly active are not sharply defined. In addition, more limited tests were made with representative isolates of each group. Twelve oz. grey cotton duck was used in one series of experiments for comparison with results obtained on sheeting. In another experiment, the utilization of wool as a *nitrogen* source was tested by omitting the NH_4NO_3 of the nutrient solution and adding one per cent sucrose for comparison with the previous results where the wool was the only carbon source. In a third series of experiments, the ability of representative isolates to degrade filter paper was determined by incubation in shake flasks in accordance with the method previously described (**3**). Loss in weight was used as a criterion of cellulolytic activity.

The practical value of data obtained on wool that has been auto-

claved is questionable, since woolen cloth is never subjected to such treatment in actual service. In field tests, the only fungi found to degrade wool are the dermatophytes and members of the Gymnoascaceae. On the other hand, the results on autoclaved wool may be of some value to those seeking organisms capable of attacking other proteinaceous materials. Eventually, perhaps, the more active of the organisms attacking autoclaved wool may be tested on wool sterilized by some other means. Preliminary experiments from these laboratories (**7**) indicate that unautoclaved wool is resistant to most of the fungi tested. Under field conditions, most severe degradation of unautoclaved wool seems to be caused by bacteria and actinomycetes rather than by fungi. Such degradation is most rapid when the fabric is in contact with the soil.

The following represents a generalized summary (TABLE 1) of the results. Each *Aspergillus* group is arranged in the order of its activity. *A. terreus, A. fumigatus,* and *A. flavipes* were the only groups active on both 3.3 oz. bleached cotton sheeting and wool. *A. clavatus, A. flavus-oryzae,* and *A. tamarii* were active on wool but inactive on cotton sheeting and on duck. *A. ochraceus, A. nidulans,* and *A. rugulosus* were active on wool and grey duck but not on sheeting. The *A. ustus* group, in general, was inactive on wool and cotton sheeting, but active on grey duck. In the *A. nidulans* group, *A. unguis* was inactive on wool, but both *A. nidulans* and *A. rugulosus* (one isolate) were active. Members of this group were inactive on cellulose. The remaining groups *A. wentii, A. versicolor, A. glaucus,* and *A. niger* (with the exception of the *A. luchuensis* series on grey cotton duck) proved inactive on both cellulose and on wool.

A close relationship between physiological activity and morphology is shown (TABLE 1). The various isolates of a species are remarkably alike in their physiological properties as determined by these degradation studies. Furthermore, morphologically stable species tend to be more uniform physiologically than species showing greater variation in growth patterns. Thus, the isolates of *A. fumigatus* are similar morphologically and in their abilities to degrade autoclaved wool and cotton sheeting, while the morphologically dissimilar isolates of *A. ustus* tend to show greater variability in their activity on the two substrata used.

TABLE 1

ACTIVITY OF *Aspergillus* ISOLATES ON WOOL AND COTTON

Groups (13) Species (36)	Number of isolates	Average % loss in T.S.**			Activity distribution of isolates			
		Wool	Cotton		Wool	Cotton		
		Charmeen	Sheeting 3.3 oz.	Grey duck 12 oz.	Charmeen A* I*	Sheeting A* I*	Grey duck A* I*	Grey duck (Marsh) A* I*
A. terreus group	36							
A. terreus	35	65	68	77	35—0	35— 0	6—0	7—0
A. niveus	1	38	73	79	1—0	1— 0	1—0	1—0
A. fumigatus group	31							
A. fumigatus	24	53	77	84	24—0	24— 0	2—0	9—0
A. fischeri	7	67	61	55	7—0	5— 2	3—0	
A. flavipes group	4							
A. flavipes	4	27	38	71	3—1	4— 0	3—0	7—0
A. clavatus group	4							
A. clavatus	3	68	6	7	3—0	0— 3	0—3	8—4
A. giganteus	1	3	19	58	0—1	1— 0	1—0	2—0
A. flavus-oryzae group	48							
A. oryzae	2	70	8	6	2—0	0— 2	0—2	0—2
A. flavus	42	68	1	5	42—0	0—42	0—7	0—7
A. parasiticus	2	53	2	8	2—0	0— 2	0—2	0—1
Unclassified	2	57	7	2	2—0	0— 2	0—2	

* A = Active, I = Inactive

** Though not justifiable mathematically, an average per cent loss gives a value that can be useful in comparing activities of the different species.

TABLE 1—*Continued*

Groups (13) Species (36)	Number of isolates	Average % loss in T.S.**			Activity distribution of isolates			
		Wool	Cotton		Wool	Cotton		
		Charmeen	Sheeting 3.3 oz.	Grey duck 12 oz.	Charmeen A* I*	Sheeting A* I*	Grey duck A* I*	Grey duck (Marsh) A* I*
A. tamarii group	15							
A. tamarii	15	58	5	5	15— 0	0—15	0—3	0—7
A. ochraceus group	5							
A. ochraceus	4	53	0	36	4— 0	0— 4	3—1	4—0
A. sclerotiorum	1	79	0	13	1— 0	0— 1	0—1	0—1
A. ustus group	34							
A. ustus	30	12	11	49	7—23	9—21	30—0	3—1
A. ustus var. *laevis*	4	0	3	12	0— 4	0— 4	1—3	1—0
A. nidulans group	31							
A. unguis	26	5	1	8	1—25	0—26	0—6	0—2
A. nidulans	4	30	7	25	3— 1	1— 3	2—2	2—0
A. rugulosus	1	45	0	50	1— 0	0— 1	1—0	1—0
A. wentii group	2							
A. wentii	1	4	8	10	0— 1	0— 1	0—1	0—5
A. panamensis	1	0	5	13	0— 1	0— 1	0—1	
A. versicolor group	78							
A. sydowi	47	2	2	4	0—47	0—47	0—8	0—6
A. versicolor	31	2	2	7	0—31	0—31	0—5	0—5

TABLE 1—*Continued*

Groups (13) Species (36)	Number of isolates	Average % loss in T.S.**			Activity distribution of isolates			
		Wool	Cotton		Wool	Cotton		
		Charmeen	Sheeting 3.3 oz.	Grey duck 12 oz.	Charmeen A* I*	Sheeting A* I*	Grey duck A* I*	Grey duck (Marsh) A* I*
A. glaucus group	35							0—3
A. repens	14	2	4	6	0—14	0—14	0— 3	
A. chevalieri	15	1	2	8	0—15	0—15	0— 2	
A. chevalieri var. *intermedius*	2	0	3	2	0— 2	0— 1	0— 1	
A. montevidensis	1	0	3	6	0— 1	0— 1	0— 1	
A. restrictus	3	0	3	6	0— 3	0— 3	0— 2	
A. niger group	99							
A. niger series								
A. niger van Tieghem	13	0	0	22	0—13	0—13	1—11	0—3
A. niger mut. *cinnamomeus*	1	0	3	1	0— 1	0— 1	0— 1	0—2
A. niger mut. *schiemanni*	1	5	0	39	0— 1	0— 1	1— 0	
A. foetidus	1	0	0	0	0— 1	0— 1	0— 1	0—1
A. phoenicis	1	0	10	8	0— 1	0— 1	0— 1	0—1
A. carbonarius series								
A. fonsecaeus	1	0	0	1	0— 1	0— 1	0— 1	
A. carbonarius	1	0	0	1	0— 1	0— 1	0— 1	0—1
A. luchuensis series	14	1	2	24	0—14	0—14	8— 4	2—3
A. niger group unclassified	66	0	0	1	0—66	0—66	0—25	
Total	422							

Of the 422 isolates examined, only seven appear to differ from others in their respective groups in their behavior on autoclaved wool and on cotton sheeting. Originally, several others also appeared to be exceptions. Closer examination revealed either that these had been improperly identified, or that contaminants were present. In the latter case, after purification of the culture, the organism behaved in a manner characteristic of the species. Because of this uniformity, exceptional behavior on a substratum is suggestive of contamination or mis-identification. The following exceptions have been noted. Two of the seven isolates of *A. fischeri* tested differ from the other twenty-nine members of the *A. fumigatus* group in being unable to attack cotton sheeting. They were, however, active on grey duck, and the inability to attack the sheeting may have been due to a nutrilite deficiency. It is interesting to note that both isolates originated in Florida, and that both were somewhat different macroscopically from our other isolates of *A. fischeri*. One isolate of *A. flavipes* differed from the others in its inactivity on wool. All of the other members, however, might be classed as weakly active on this substratum. The results of Marsh (2) relative to the activity of *A. giganteus* were confirmed. This species, of which only one representative was tested, differed from the other members of the *A. clavatus* group in being active on cotton, but not on wool. In the *A. nidulans* group, one of twenty-six isolates of *A. unguis* was able to attack wool, and only one of four isolates of *A. nidulans* was able to degrade cotton sheeting. Three of four isolates of *A. nidulans* attacked wool.

The relationships found above are based on results obtained under a definite set of conditions. The data resulting from other tests are in general agreement with those given. Organisms capable of using autoclaved wool as a carbon source were also able to degrade the same material when it was the only N-source (in the presence of sucrose). In like manner, there is agreement between the results using grey cotton duck and those using 3.3 oz. bleached cotton sheeting, except that (1) the activity is usually greater on the duck; (2) the following organisms are unable to attack 3.3 oz. sheeting but *are* able to attack duck.

(a) *A. luchuensis* series of the *A. niger* group (four exceptions, unable to attack duck).

TABLE 2

ABILITY OF SPECIES OF *Aspergillus* TO PRODUCE AN ENZYME CAPABLE OF HYDROLYZING CARBOXYMETHYL CELLULOSE

Aspergillus species		Incubation time (days)	Growth	Cx activity*
Cellulolytic species				
A. fumigatus	QM 45h	9	4+	.14
A. fumigatus	QM 6b	9	2+	.22
A. fischeri	QM 864	9	4+	.13
A. terreus	QM 82j	9	4+	.31
A. terreus	QM 91c	9	4+	.31
A. flavipes	QM 24a	9	4+	.27
Non-cellulolytic species				
A. clavatus	QM 862	9	4+	.11
A. chevalieri	QM 312	20	none	—
A. repens	QM 210	20	none	—
A. nidulans	QM 25b	20	2+	.28
A. unguis	QM 8f	20	4+	.27
A. ustus	QM 29c	9	4+	.56
A. ustus	QM 892	9	4+	.43
A. sydowi	QM 4d	9	4+	.40
A. sydowi	Fla. F 3	9	4+	.38
A. versicolor	QM 17d	9	4+	.31
A. niger v. Tiegh.	QM 458	9	4+	.21
A. carbonarius	QM 331	9	3+	.02
A. tamarii	QM 50b	9	4+	.35
A. tamarii	QM 75b	9	4+	.38
A. flavus	QM 4m	9	4+	.28
A. flavus	QM 63c	9	4+	.20
A. ochraceus	QM 26b	9	4+	.12

* Cx activity: 5 ml. 1% CMC 50T + 1 ml. M/2 citrate pH 5.0 + 3 ml. water + 1 ml. cell-free filtrate. Temperature 50° C; time 1 hour. Results expressed as reducing sugar in terms of glucose in mg./ml. of mixture/hour.

(b) *A. niger* v. Tiegh. One isolate (of 13) represents an exception to the rule that no *black* Aspergilli attack cellulose, the members of the *A. luchuensis* series and *A. niger* mut. *schiemanni* *not* being black. It is like the latter, however, in being able to attack grey duck but not cotton sheeting. Raper, in verifying the correctness of the identification, states: "this [organism] obviously suffers from some nutrient deficiency as evidenced by its very limited growth on Czapek solution agar. Perhaps this deficiency might in some way be related to its cellulolytic properties."

(c) *A. niger* mut. *schiemanni.*

(d) *A. ustus* was highly variable in its attack on cotton sheeting but all isolates attacked the grey duck.

(e) *A. ochraceus* group (two exceptions, unable to attack duck).

The results of Marsh (**2**) on duck agree quite well with ours for the same substratum, except perhaps for *A. clavatus.* In this group, Marsh found a preponderance of active strains in contrast to the inactivity recorded for our more limited number of isolates.

Growth of species of Aspergillus on carboxymethyl cellulose. Organisms representing the various groups in the genus *Aspergillus* were tested for their ability to grow on carboxymethyl cellulose (CMC) [1] in shake flasks. At the end of incubation, the cultures were filtered and the filtrates tested for ability to hydrolyze CMC (TABLE 2) by methods previously described (4). The time of incubation was varied in accordance with the rate of growth of the cultures. All of the Aspergilli tested possess the ability to produce the enzyme Cx. The absence of growth by two members of the *A. glaucus* group (QM 312 and QM 210) is not unusual, these being difficult organisms to grow in shake-cultures. The low activity of the *A. carbonarius* filtrate is in opposition to the good growth obtained. The two members of the *A. nidulans* group (QM 25b and QM 8f) showed fair growth but no activity in the filtrates after 9 days incubation. Yet the 20-day filtrates had good activity. This effect of culture age on filtrate activity has been frequently observed.

DISCUSSION

Cellulose which has undergone various chemical and physical steps during purification differs in its susceptibility to degradation by microorganisms. The effects of such treatments may be summarized as follows:

(a) Increase in surface area renders cellulose more easily attacked.

(b) Decrease in crystallinity or decrease in "cross linkages" between cellulose chains. For example, viscose rayon and cuprammonium rayon are more readily attacked than the initial cellulose.

[1] CMC 50T supplied by Hercules Powder Company, Wilmington, Delaware. Degree of substitution 0.52.

(c) Removal of impurities may lead to apparent resistance. Highly bleached and desized cotton cloth may not support growth of an organism due to the absence of growth factors, whereas the same organism may grow well on the untreated fabric. This type of resistance may be overcome by adding the proper vitamins, minerals, etc.

(d) Deposition of chemicals. Incomplete removal of bleaches or other chemicals may inhibit fungus growth.

(e) Chemical modification of the cellulose molecules by substitution tends to increase resistance. As the number of added substituents per anhydroglucose molecule increases, the resistance increases. One substituent on every anhydroglucose unit appears to confer complete resistance.

It is not unusual then, that bleached cotton sheeting differs from the more crude cotton duck in its susceptibility to attack by microorganisms. Where differences occur, the duck is the more rapidly degraded. Though this problem has been considered before (**8**), it is not yet certain that the answer is simply growth factor deficiency. For instance, treatment of the resistant, bleached sheeting with alkali has been found to permit growth of *A. luchuensis* (QM 873) on fabric which would not otherwise support growth. While these data may indicate that the resistance is due to a toxic chemical present in the fabric, the problem is not so simple since filter paper is also resistant. It seems unlikely that the same chemical impurity would be present there as in the bleached sheeting. As a rule, our results on decomposition of filter paper in shake flasks agree with the data on loss in tensile strength of cotton sheeting.

Since all of the Aspergilli seem capable of hydrolyzing the linkages between anhydroglucose units in straight chain molecules derived from cellulose, it appears that the difference between cellulolytic and non-cellulolytic must be in the ability to carry on an earlier step by means of the postulated enzyme (C_1). The ability to produce the enzyme Cx is common to all Aspergilli. The non-cellulolytic members of the genus produce as large amounts as do the cellulolytic species. Most of the strains tested produce much more Cx if a substratum is present which contains the 1,4 β-glucosidic linkage in long chains. The enzyme diffuses readily into

the medium, a requirement if such long molecules are to be split up to permit diffusion into the cell.

A close correlation is found in the Aspergilli between the morphological entity as exemplified by the species or group, and the physiological activity. Such data are useful in evaluating results given in the literature, even when the organism then used is no longer available. Thus, Basu (**1**) in a recent paper, reports his strains of *Aspergillus niger* as non-cellulolytic, and *A. ustus, A. terreus, A. fumigatus,* and *A. sydowi* as cellulolytic. All of these but one are in agreement with the data gathered in this report. It appears unlikely that the organism he calls *A. sydowi* is correctly named since none of 53 isolates of that organism tested by us or by Marsh has any cellulolytic action. Such a conclusion must, however, be accepted with reservations.

For ready reference, the groups may be brought together on the basis of activity as follows:

A. *Active on Cellulose*
  1. *Active on wool*
    a. Active on cotton sheeting and grey duck
      A. terreus, A. niveus
      A. fumigatus, A. fischeri
      A. flavipes
    b. Active on grey duck but not on sheeting
      A. ochraceus
      A. nidulans, A. rugulosus
  2. *Inactive on wool*
    a. Active on sheeting and on duck
      A. giganteus
    b. Active on grey duck but not on sheeting
      A. ustus
      A. niger mut. *schiemanni*
      A. luchuensis series (see below)

B. *Inactive on Cellulose*
  1. *Active on wool*
      A. clavatus
      A. flavus, A. oryzae, A. parasiticus
      A. tamarii
      A. sclerotiorum

2. *Inactive on wool*
   A. unguis
   A. wentii, A. panamensis
   A. versicolor, A. sydowi
   A. repens, A. chevalieri, A. montevidensis, A. restrictus
   A. carbonarius series
   A. niger series (except *A. niger* mut. *schiemanni*)
   A. luchuensis series (except for above)

SUMMARY

1. The isolates of any particular species of *Aspergillus* are alike in their ability to attack a particular substratum, such as cellulose or wool.

2. Some species of *Aspergillus* can attack both autoclaved wool and cotton, some one but not the other, and still others can attack neither.

3. Some species of *Aspergillus* are capable of degrading crude cotton duck but not the more pure cellulose of bleached cotton sheeting. These organisms are cellulolytic. Failure to grow on the cotton sheeting must be attributed to other causes.

4. All members of the genus *Aspergillus* appear to be capable of hydrolyzing the 1,4 β-glucosidic linkages found in the cellulose chain.

PHILADELPHIA QUARTERMASTER DEPOT,
PHILADELPHIA, PA.

LITERATURE CITED

1. **Basu, S. N.** 1948. Fungal decomposition of jute fiber and cellulose. Jour. Text. Inst. **39** (7) : 232–237.
2. **Marsh, P. B., K. Bollenbacher, M. L. Butler, and K. B. Raper.** 1949. The fungi concerned in fiber deterioration. II: Their ability to decompose cellulose. Text. Res. Jour. **19**: 462–484.
3. **Reese, E. T.** 1947. On the effect of aeration and nutrition on cellulose decomposition by certain bacteria. Jour. Bact. **53** (4) : 389–400.
4. ——, **R. G. H. Siu, and H. S. Levinson.** 1950. The biological degradation of soluble cellulose derivatives and its relationship to the mechanism of cellulose hydrolysis. Jour. Bact. **59** (4) : 485–497.
5. **Thom, C., and K. B. Raper.** 1945. A manual of the Aspergilli. Williams and Wilkins Company, Baltimore, Maryland.

6. **White, W. L., R. T. Darby, G. M. Stechert, and K. Sanderson.** 1948. Assay of cellulolytic activity of molds isolated from fabrics. Mycologia **40**: 34–84.
7. ——, **G. R. Mandels, and R. G. H. Siu.** 1950. Fungi in relation to the degradation of woolen fabrics. Mycologia **42**: 199–223.
8. ——, **R. G. H. Siu, and E. T. Reese.** 1948. The black Aspergilli in relation to cellulosic substrata. Bull. Torrey Bot. Club **75**: 604–632.

NEW SPECIES OF CELLULOSE DECOMPOSING FUNGI. III

L. M. AMES [1]

(WITH 15 FIGURES)

Continued studies of cellulose decomposing fungi, isolated from military material and equipment, have revealed several new species in the *Chaetomiaceae* belonging to the genus *Ascotricha*. The genus *Ascotricha* has received scant attention since two species, *A. chartarum* Berkeley and *A. pusilla* (Ellis & Everhart) Chivers, were reported in 1890 and 1915.

The two species presently described were found growing on military fabric and packaging material which was obtained in the Pacific area by Dr. W. Lawrence White and Dr. Charles C. Yeager during their trip with the Army Air Forces Tropical Science Mission, Air Technical Service Command, from January 1946 to May 1947.

These two species were dominant on the material from which they were isolated, while other collections supported mixed cultures of fungi, among them being two additional species of *Ascotricha*, which have received insufficient study for inclusion in this paper. It is hoped that interest in the genus will be revived and additional material and information will increase for the benefit of the individuals and agencies interested in cellulose decomposing fungi.

Ascotricha xylina sp. nov.

Nigra. Peritheciis superficialibus, globosis vel subglobosis, basi rotundis, 90–110 μ (75–100 × 80–120 μ), ostiolatis, cum cirrhis vel sporis laxe acervatim inter pilos terminale cohaerentibus, vix ad substratum rhizoideis affixis; collo circa 40 μ longo et 25 μ crasso, papilliformi. Pilis lateralibus paucis, gracilibus, septatis, geniculatis, ampullatis, simpliciter vel compositer ramosis, basi 1.5–2.25 μ diametro, circa 200–450 μ longis. Pilis terminalibus e collo ortis, basi 1.75–2.50 μ diametro, septatis, simpliciter vel compositer ramosis, geniculatis, ampullatis, tenuibus, circa 450–650 μ longis. Ascis longis, cylin-

[1] Research Mycologist at the Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

dricis, octosporis, 47 × 8.5 μ. Ascosporis maturis brunneis, concavis, ovatis vel subovatis, 7.5 × 10 μ (6.5–8 × 8–10.5 μ), lateraliter observatis vix 4.5–5.25 μ.

Black. Perithecia globose to subglobose, constricted above to form a short, distinct neck, rounded at the base, 90 × 110 μ (75–100 × 80–120 μ), extruding spores into the slender branched terminal hairs as a black mass or frequently in the form of cirrhi, loosely affixed to the substratum amidst numerous conidiophores bearing copious quantities of conidia. Lateral hairs sparsely scattered over the perithecium, slender, septate, ampullate, of variable lengths, to 450 μ. Terminal hairs arising from the region of the neck attaining a length of 650 μ or more, slender, 1.75–2.25 μ in diameter, septate, in mass black, becoming glossy with age, separately dilute black, ampullate, simply or compoundly branched. Asci delicate, linear, cylindrical, 8-spored, 47 × 8.5 μ. Spores monostichous, when mature dark olive-brown, 7.5 × 10 μ (6.5–8 × 8–10.5 μ), ovate, roughly egg-shaped, rounded at the ends, when seen edge-wise, compressed 4.5–5.25 μ. Conidia smooth, general outline pear-shaped, 3.5–4 × 5μ. Conidiophores partly greenish when young becoming dark with maturity, some terminal parts hyaline.

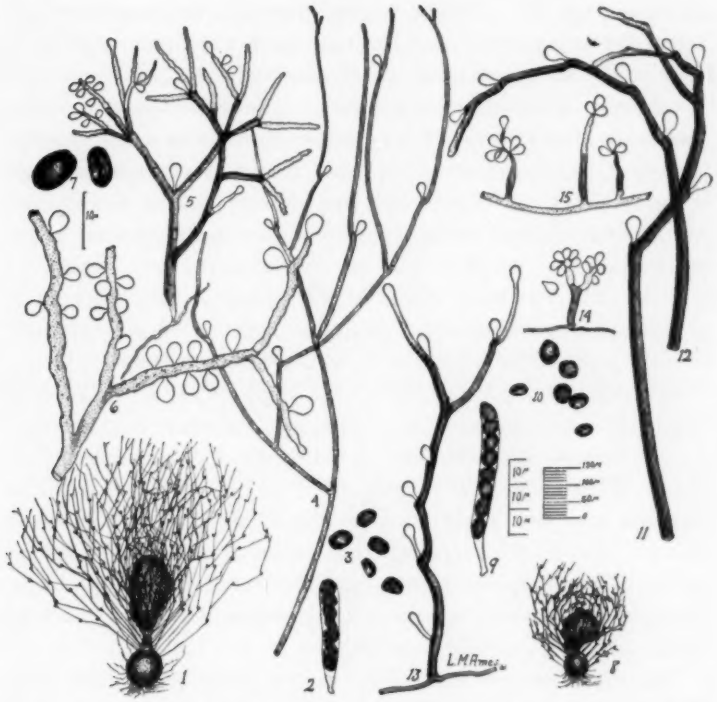
Isolated from cotton duck obtained at Manila, Manila No. 5 of White and Yeager.

Ascotricha guamensis sp. nov.

Nigra. Peritheciis magnitudinis mediae, globosis vel subglobosis, ad basim rotundis, 65–80 μ (60–90 × 75–110 μ), ostiolatis, cum rhizoideis gracilibus, cirrhis conspicuis; collo circa 20 μ longo et 10 μ crasso papilliformi. Pilis lateralibus paucis, robustis, obscure septatis, nigris, 4–5 μ diametro, geniculatis, ampullatis, interdum ramosis. Pilis terminalibus e collo ortis, basi 4.5–6.5 μ diametro, circa 250–300 μ longo, robustis, atris, obscure septatis, interdum ramosis, apicibus retusis. Ascis longis, cylindricis, octosporis, 68 × 8 μ. Ascosporis maturis brunneis, concavis, ovatis vel subovatis, 7.5 × 8.5 μ (7–9 × 8–10 μ), lateraliter conspecta 4–5 μ.

Black. Perithecia globose to subglobose, constricted to a short, thick neck at the upper extremity, rounded at the base, 65 × 80 μ (60–90 × 75–110 μ), extruding spores into the stiff branched terminal hairs as a black mass or frequently forming cirrhi, loosely affixed to the substratum among conidiophores bearing abundant quantities of conidia. Lateral hairs sparsely scattered over the upper rounded portion of the perithecium, stout, obscurely septate, dark olive-brown to black, generally curving inward, about 4–5 μ in diameter, gradually tapering, becoming pale olive at the blunt tips, jointed, ampullate, occasionally branched. Terminal hairs

arising from the region of the neck, averaging about 250–300 μ in length, dark olive-brown to black, stiff, simple or compositely branched, ampullate, obscurely septate, 4.5–6.5 μ in diameter, gradually tapering to a blunt point. Asci delicate, linear, cylindrical, 8-spored, 68 × 8 μ. Spores monostichous, when mature dark olive-



FIGS. 1–7, *Ascotricha xylina;* FIG. 1, mature perithecia; 2 and 3, ascus and ascospores; 4, detail of a terminal hair; 5, conidiophore with a few attached conidia; 6, higher magnification of the conidia-bearing branches of conidiophore; 7, detail of ascospores. FIGS. 8–15, *Ascotricha guamensis;* FIG. 8, mature perithecium; 9–10, ascus and ascospores; 11–12, detail of terminal hairs; 13, ampullate branch arising from agar media surface; 14–15, conidiophores and conidia.

brown, 7.5 × 8.5 μ (7–9 × 8–10 μ), ovate or roughly egg-shaped, rounded at the ends, when seen edge-wise, compressed 4–5 μ. Conidia smooth, general outline pear-shaped, 3–4 × 6 μ. Portions of the conidiophores greenish when young becoming dark with maturity, some terminal parts hyaline.

Isolated from cardboard boxes of photographic film which was stored in an army warehouse, Guam, Guam No. 3 of White and Yeager.

Species of *Ascotricha* are easily distinguished from those of *Chaetomium* by the ampullate, jointed perithecial hairs and the presence of conidia. Conidial growth precedes the development of the perithecia; the conidia may be round and smooth or roughened, fusiform or pear-shaped, and borne on simple, sympodially or dichotomously branched conidiophores. The conidiophores, when young, are grayish-green in color becoming black at maturity with the exception of many terminal spore-bearing branches which may be light-colored. The perithecia are loosely attached to the substratum, are flanked by conidiophores or may frequently grow superficially on compact mats of conidiophores and vegetative growth. The species of *Ascotricha* described in this paper were grown on maize meal and potato extract agar with a strip of cloth or filter paper added, as described in a previous paper (**1**).

In contrast to the heavy, dark conidiophores and terminal hairs which are conspicuous to the unaided eye, abundant, slender, non-jointed hyphae were observed in the media and within cellulosic fibers. Delicate hyphae ranging from 1.75 μ to less than 1 μ in diameter have been observed ramifying within the lumen of wood fibers. That fibers are weakened, presumably by the digestive action of the fungi, is substantiated by breaking strength tests. Hyphae from various species of *Chaetomium* have been observed within fibers in a similar manner.

The prevalence of *Ascotricha* in the material received from White and Yeager, in addition to numerous collections obtained from wood, paper and fabric in our Tropical Testing Chamber at Fort Belvoir, gives strong evidence that they are important as cellulose destroyers which merit much critical attention. A newly awakened interest in the genus may bring to light more conclusively that they are responsible for appreciable amounts of cellulosic deterioration referred to by the general term "mildew." The jointed terminal hairs with their characteristic ampullae should make easy genus determination.

The genus *Ascotricha* was first described and published by M. J. Berkeley in the Annals of Natural History (**2**). The characteris-

tics were described as follows: "Peridium thin, at length bursting, clothed with dark, subpellucid, even, obscurely jointed hairs; sporidia simple, contained in linear asci. Superficial, at length free or only supported by the investing thallus, black." This description was accompanied by a complete description of a single species, *A. chartarum,* and illustrated with six figures. To date only one additional species has been described. This appeared first under the name *Chaetomium pusillum* Ellis & Everhart in 1890 (**4**, p. 220). The description was emended and the species transferred to the genus *Ascotricha* in 1915 by Chivers (**3**), the binomial becoming *Ascotricha pusilla* (Ellis & Everhart) Chivers.

The writer thanks Dr. W. Lawrence White and Dr. Charles C. Yeager for the materials from which the fungi were isolated.

REFERENCES

1. **Ames, L. M.** New cellulose destroying fungi isolated from military materials and equipment. Mycologia **41**: 637–648. 1949.
2. **Berkeley, M. J.** Notices of British fungi. Annals of Natural History **1**: 257–264, pl. 7–8. 1838.
3. **Chivers, A. H.** A monograph of the genera *Chaetomium* and *Ascotricha.* Memoirs of the Torrey Botanical Club **14** (3): 155–240. 1915.
4. **Ellis, J. B., and B. M. Everhart.** New North American fungi. Proc. Acad. Nat. Sci. Phila. **42**: 219–249. 1890.

STUDIES IN THE GENUS PLEOSPORA. III

LEWIS E. WEHMEYER

(WITH 23 FIGURES)

In previous papers (**10, 11, 12**) the writer has treated the evolution of spore-form and septation within the genus *Pleospora*. The present paper treats those species which have setose, or tomentose and then setose, perithecia. These are the species which have been retained in the genus *Pyrenophora* by many authors.

Petrak (**5**) in a recent report upon numerous collections of *Pleospora* from the near east, expressed the opinion that there are many intergrades between smooth and setose perithecia and that the presence or absence of such appendages is not a constant character even at the species level. The present writer is in agreement with the statement that many intergradations occur, and does not believe that the character is of generic value. If we rule out the character at the species level because of intergrading cases, however, our species concepts will become so broad as to be unwieldly. As in previous groups, therefore, the writer believes that a certain amount of arbitrary selection must be used to delimit species.

The great majority of species with setose or strongly tomentose perithecia lie within a restricted spore group corresponding to that discussed under the *herbarum* series in previous papers (**9, 11**). A few species (*i.e., P. trichostoma, P. calvescens, P. tomentosa, P. pleosphaerioides*) have been mentioned in other spore series. The great majority of setose collections however, form a compact group, which in spore form and septation seem to be derived from species with smooth perithecia in the *herbarum* series.

This origin of tomentose to setose hyphae on the perithecium seems to be correlated with habitat and certain other characters. Such setose species are a common and distinctive element of the *Pleospora* flora of high altitudes and high latitudes. They abound in regions where herbaceous stems and leaves lie beneath a heavy covering of snow for long periods at low temperatures, and where

there is abundant moisture for a long period in the spring as a result of the melting of this snow.

All degrees of development of this tomentum on the perithecium can be found. In fact many of the collections placed in the *herbarum* series previously discussed (*i.e., P. herbarum* var. *occidentalis, P. richtophensis*) may show a fine brown tomentum which becomes coarser and darker-colored in many cases. As this tomentum increases in amount, the hyphae become stiffer and darker, and some on the upper surface may become straight and pointed and setose. Such upright hyphae may penetrate the epidermis or develop more definitely when the upper surface of the perithecium is exposed. The final stage is the development of a definite cluster of stiff, upright, dark, pointed setae about the ostiole. Only collections showing such setose, spine-like hyphae are included in this group. Even so, a collection may often show only a few perithecia with such spines, for they often break off or fail to develop.

Along with this development of a stiff tomentum and then setae there are certain other correlated changes. The perithecia become smaller, and change from a flattened-globose to a globose, and then pyriform shape, with more strongly erumpent and elongate conic ostioles. The spores tend to become larger, more septate and often of a dark brown color.

Table I shows the setose collections which have been studied, arranged according to spore size, septation and to a certain extent form. These collections again comprise a confusing group, but if the series is examined in its entirety it can be seen that it parallels rather closely the *herbarum* series previously discussed (**12**). It is possible also to group these collections into species which correspond rather closely with those differentiated in the herbarum series. Here again this must be done in a somewhat arbitrary fashion.

The single collection (No. *327*), designated as *Pleospora* sp., has the *vulgaris* type spore (FIG. 1) but of a size found in *P. richtophensis.*

The two following species, *P. angustata* and *P. ambigua* correspond to *P. media* in having mostly five- but sometimes seven-septate spores which often show vertical septa in the end cells. *P. angustata* has the spore form of *P. vulgaris* with acute ends,

TABLE I

Coll. No.	Host.	Spores	Asci	Perithecia
		Pleospora sp.		
327	Grass	26.5–32 × 10–12.5	75–90 × 23–26.5	150–200, S
		Pleospora angustata nom. nov.		
141a	Composite	16–18 × 7–7.5	75–90 × 12.5–14	200–250, T
326	Solidago	19.5–22 × 7–8.5	100–115 × 11–14	200–300, T, S
137	Tofieldia	19.5–23 × 8.5–9	95–100 × 14–16	200–300, T, S
340	Braya	21.5–26 × 9–10	75–80 × 21.5–23	150–200, S
		Pleospora ambigua (Berl. & Bres.) comb. nov.		
138	Lupinus	19.5–26.5 × 9.5–12.5	85–95 × 19–23	150–250, T
168	Androsace	21.5–26 × 9–12.5	88–106 × 18–21	100–200, S
142	Scleranthus	21.5–25 × 8.5–9	70–88 × 17–21	100–150, S
348	Arabis	21.5–26 × 8.5–9.5	75–95 × 17–19	200–250, S
139	Aster	22–25 × 10.5–12.5	78–90 × 19–23	175–250, T
140	Telekia	23–26 × 11–12	85–95 × 18–20	250–300, S
		Pleospora helvetica Niessl		
444	Senecio	20–26.5 × 10.5–12	88–110 × 17–19	250–300, T, S
143	Stem	21.5–26 × 9.5–11.5	100–110 × 19–22	200–300, T, S
338	Potentilla	23–25 × 9–10.5	90–120 × 17	200–250, T, S
144	Grass	23–26 × 11–12	88–125 × 17–22	150–200, S
141	Composite	25–27 × 10–11.5	125 × 18–21.5	200–300, T
328	Barbaraea	25–28 × 10–12.5	105–140 × 17–24	200–250, T
146	Umbellifer	25–28.5 × 11–12	125 × 18–21.5	200–400, T, S
148	Phyteuma	26–30 × 11–12.5	78–100 × 22–24	300–350, T
		Pleospora Tragacanthae Rab.		
145	Trifolium	24.5–30 × 11–13	85–95 × 24–28	130–175, S
151	Astragalus	26–34 × 14	110–125 × 26–32	100–150, S
150	Cerastium	28–34 × 13–16	125–140 × 13–16	150–200, S
130	Silene	26–37 × 11–16	95–110 × 24–29	200–300, S
149	Artemisia	26–37 × 11–14(16)	95–110 × 24–29	300–400, S
70	Phaca	28–32 × 11–13	95–110 × 24–26	200–300, S
347	Arenaria	30–34 × 12.5–14	90–115 × 24–26	200–250, S
152	Astragalus	30–35 × 13–15	100–130 × 26–28	250–350
154	Tetraneuris	30–37 × 12–18	95–110 × 32–35	150–350, S
155	Astragalus	32–35 × 14–15.5	110–130 × 26–30	S
136	Zygadenus	32–37 × 10.5–14.5	100–123 × 15	250–350, S
		Pleospora comata Niessl		
123	Ranunculus	28–37 × 12.5–15	106–115 × 32–35	150–300, S
153	Frasera	30–40 × 13–18	85–160 × 32–35	150–200, S
157	Cousinia	35–41 × 17–19	100–135 × 30–35	200–250, T, S
156	Phlox	35–40 × 16–18	175–200 × 30–35	200–250, S
158	Phlox	36–42 × 13–18	125–190 × 33–35	100–200, S
301	Balsamorrhiza	39–50 × 14–18	175–210 × 30–40	250–300, S
		Pleospora kouh-sefidica Frag.		
504	Astragalus	44–48 × 17–19.5	100–140 × 50–60	200–250, S
		Pleospora abbreviata Fck.		
313	Phaca	33–37.5 × 13–16	140 × 28–30	200–250, S

corresponding to the var. *acuta* of *P. media* whereas *P. ambigua* has spores with blunt ends as in *P. media* var. *obtusa*.

The first three species, just mentioned, have spores with five to seven septa, but more commonly five septa and there is only one vertical septum in the central cells, or sometimes in the end cells. The spores of all the following species have mostly seven or more septa and usually show two or more vertical septa in face view of the central cells. They are most characteristic of arctic-alpine environments and present a bewildering array of variations in spore form, size, septation and perithecial appendages. They are, here, arbitrarily separated into four species groups, as follows.

The name *P. helvetica* Niessl is applied to those collections with spores less than 30 μ in length, and usually with perithecia which are both tomentose and setose. *P. Tragacanthae* Rab. is used for a group of collections which always show some spores over 30 μ and up to 40 μ in length and in which the perithecia are usually found with an apical fascicle of upright stiff setae and usually no basal tomentum. These two species correspond to the *P. herbarum* group with smooth perithecia. *P. comata* Niessl is provisionally used for a group of collections in which the spores show oblique or extra septa (8- to 9-septate) in the lower end, corresponding to *P. coloradensis* and *P. njegusensis* with smooth perithecia. *P. kouh-sefidica* has similarly septate spores which, however, are much larger (40–50 μ long).

If one examines the literature, it is obvious that everyone who has studied these arctic-alpine species has had difficulty in the separation of species. The binomials and descriptions which fall in this grouping show even greater confusion than the accompanying table presents. The use of binomials, as evidenced from exsiccati, collections and descriptions in the literature, has obviously varied with the determinor. In fact the confusion and disagreement is so great that only personal examination of type material can determine the proper use of binomials, and until such opportunity, a provisional usage must be followed.

Petrak (**5**, **6**) encountered similar difficulties in his studies of this group of species in the near east. As concerns the latter group, with 7- or more septate spores, he describes briefly a large number

of collections and places them in three species with spore ranges as follows:

P. brachyspora	23–36 × 12–17 μ
P. Tragacanthae	(22)25–42 × 12–20 μ
P. chlamydospora	(26)30–70 × 14–32 μ

Petrak did not distinguish species on the basis of smooth or setose perithecia but includes both types in each of these species. His groupings, therefore, are not identical with those used here. As can be seen, his spore ranges for the three species overlap widely, and he recognizes this difficulty. He also includes a few collections with seven to nine septa, which would be included in *P. comata* as here described.

His *P. brachyspora* is similar to the *P. helvetica* of this paper; in fact he says that it is near *P. chrysospora* or *P. chrysospora* var. *polaris,* which also fall in this same grouping. The writer has seen only three collections with seven-septate spores as large as those occurring in Petrak's *P. chlamydospora,* and two of these came from the same region (Persia). *P. chlamydospora* was originally described by Saccardo (**8**, p. 139) and figured by Berlese (**2**, pl. 34) as having small non-setose perithecia and with spores 35 × 18 μ according to Saccardo and 45–52 × 23–25 μ according to Berlese. Petrak bases his discussion upon a *Pleospora* taken from the original host plant collection. This *Pleospora* has setose perithecia and spores 47–55 × 20–25 μ. In the three collections seen by the writer, the hairs or setae often varied from one perithecium to another of the same collection, and these collections were placed in *P. Balsamorrhizae* (**12**). It seems likely that another species group exists with setose perithecia and 7-septate spores, larger than those of *P. Tragacanthae.*

Pleospora abbreviata Fck., is similar to *P. Tragacanthae,* but there is usually a further, although irregular, insertion of tertiary walls in the 7-septate spore.

PLEOSPORA sp. (FIGS. 1, 9).

Perithecia 150–200 μ in diameter, rather thickly scattered, globose to pyriform, immersed, then erumpent, with a cluster of long,

pointed, septate, dark brown setae at the apex about the ostiole. Setae 150–200 μ long.

Asci broad-clavate, with thickened apical walls and a claw-like base, 75–90 × 23–26.5 μ.

Spores biseriate to triseriate, fusoid-ellipsoid, dark yellow-brown to red-brown, 5–(6)-septate, straight or slightly inequilateral, symmetric, ends tapered or bluntly rounded, slightly constricted at both primary and secondary septa, vertical septa in the central but not the end cells, 26.5–32 × 10.5–12.5 μ. One perithecium was seen which contained spores with six septa.

Collection: *327:* On grass leaves, Switzerland.

The packet containing this collection has been variously labelled, *Pyrenophora Venturia* (Speg.) Sacc., *P. chrysospora* var. *polaris* Karst., *Leptosphaeria* and *"n.sp."* The spores are of the *P. vulgaris* type, but larger and straighter than in that species. The perithecia are small and the setae are stiff, upright and clustered about the ostiole, as is common on small perithecia on leaves. It differs from forms previously placed (**12**) under *P. richtophensis* var. *pallida* only in the presence of a cluster of upright brown setae at the ostiole. *P. richtophensis* itself usually has a stiff brown tomentum on the perithecia and is very closely related although discussed in a previous paper. Inasmuch as only one collection has been seen, this small setose perithecial form is merely recorded here as *Pleospora* sp.

Pleospora angustata nom. nov. (FIGS. 2–4, 17).

Sphaeria abscondita Karst., Enum. Fung. Lapp. 216. 1865.

Pyrenophora abscondita Karst., Hedw. **23**: 37. 1884.

Perithecia 150–300 μ in diameter, rather thickly scattered, globose or depressed, immersed at first, later erumpent; usually with flexuous dark brown tomentum about the base, and stiffer, straighter pointed spine-like hyphae about the upper portion, which hyphae may penetrate the epidermis as a divergent fascicle or a few erect spines. Perithecial wall rather thick, parenchymatous.

Asci clavate to cylindric-clavate, walls somewhat thickened, base clawlike, 75–115 × 11–23 μ.

Spores overlapping uniseriate to biseriate, fusoid- to clavate-

FIG. 1. Spores of collection No. *327* of *Pleospora* sp. *2*. Spores of a collection (*340*) of *Pleospora angustata* nom. nov. 3. Spores of a collection (*326*) of *Pleospora angustata* nom. nov. 4. Spores from a collection (*141a*) of *Pleospora hispida* var. *alpina* Rehm. 5. Spores from a collection (*138*) of *Pleospora ambigua* (Berl. & Bres.) comb. nov. 6. Spores from a collection

ellipsoid, 5–7-septate, yellow-brown to reddish-brown, straight or slightly inequilateral, symmetric or asymmetric, with the lower end narrower and more tapered, ends tapered or rounded, constricted at the middle, usually five-septate, but often with a secondary septum in one or both end cells, one vertical septum in the central cells and often in the end cells (16)19–26 × 7–9(10) μ.

Collections: (89a?), *137, 141a, 326, 340;* on herbaceous stems, from the Tyrol, Sweden and Colorado.

These collections have spores which have the form of *P. vulgaris,* but show vertical walls in some of the end cells. They correspond to the type found in *P. media* variety *acuta,* but occur in setose perithecia. These spores are somewhat narrower and more acutely tapered than those of the following species.

They seem to fit the description of *Pyrenophora abscondita* Karst. Although Karsten gives the spores as three- to five-septate, Berlese (**2**, p. 37; pl. 52) figures them as 5-septate with acute ends and occasional vertical septa in the end cells, as he states in his description. The name *abscondita* is preoccupied in *Pleospora,* however, by *P. abscondita* Sacc. & Roum. and a change of name is necessary. *Pleospora phaeocomoides* (Sacc.) Wint. (*P. phaeocomes* (B. & Br.) Ces. & de Not.) as described by Niessl (**4**, p. 192) is probably this species or the following one, *P. ambigua,* for he says the spores are those of *P. media* and 18–21 × 9–11 μ, but in setose perithecia. Berlese, on the other hand, figures the spores of this species (**2**, Pl. 53, Fig. 2) as lacking vertical walls in the end cells and as being of the *vulgaris* type.

(*139*) of *Pleospora ambigua* (Berl. & Bres.) comb. nov. 7. Spores from the type collection (*142*) of *Pyrenophora Scleranthi* Starb. 8. Spores from the type collection (*168*) of *Pleospora Crandallii* E. & E. 9. Habit (a) and vertical section (b) of a perithecium of *Pleospora* sp. as found on collection No. *327.* 10. Spores from the type collection (*444*) of *Pleospora ushawaiensis* Speg. 11. Spores from a collection (*141*) of *Pleospora hispida* var. *alpina* Rehm. 12. Spores from a collection (*144*) of *Pleospora hispida* Niessl. 13. Spores from the type collection (*152*) of *Pleospora Tragacanthae* Rab. 14. Spores from the type collection (*151*) of *Pleospora spinarum* Syd. 15. Spores from a collection (*150*) of *Pleospora glacialis* Niessl & Rehm. 16. Habit (a) and vertical section (b) of perithecium from the type collection of *Pleospora Crandallii* (E. & E.) comb. nov. (*168*). 17. Habit (a) and vertical section of a perithecium (b) from a collection (*137*) of *Pleospora helvetica* Niessl.

The type collection (*89, 89a*) of *Pleospora lepidiicola* Earle bears two species of *Pleospora,* as previously stated (**12**), both of which occur in perithecia which sometimes show setae about the ostioles and might be interpreted as belonging in this series. If so, No. *89a,* which has been treated under *P. media* var. *variabilis,* would belong here.

Collection No. *141a* has the acutely tapered spores (FIG. 4) described for this species, but they are distinctly smaller than most other collections.

Pleospora ambigua (Berl. & Bres.) comb. nov. (FIGS. 5–8, 16).
Pyrenophora ambigua Berl. & Bres., Microm. Trident. (Ann. Soc. d. Alpinisti Trident.) **14**: 44. 1899.

Perithecia 100–300 μ in diameter, pyriform, globose or somewhat depressed, variously scattered on leaves and stems, immersed at first but sometimes strongly erumpent, wall membranous or somewhat thickened, of brown parenchyma, with stout flexuous hairs about the base beneath the surface and with stiff, straight, spine-like, divergent setae on the upper portion, often projecting through the surface layers of the substrate, or with a cluster of shorter stouter spines about the ostiole only.

Asci clavate, with a thickened wall and a claw-like base, 75–105 × 17–23 μ.

Spores biseriate or becoming uniseriate, oblong-ellipsoid, yellow-brown to red-brown, 5–7-septate, mostly straight or slightly inequilateral, symmetric or slightly asymmetric, tapered below, mostly five-, sometimes seven-septate, with a single vertical septum in the central and often in the end cells, ends broadly rounded, 19.5–26.5 × (8.5)9–12.5 μ.

This group of collections differs from the preceding in the form of the spore, which is broadly ellipsoid, with rounded ends and corresponds to *P. media* var. *obtusa.* They differ from the following species in the presence of only one vertical septum in face view, and the more frequent lack of secondary or vertical septa in the end cells. The two varieties are based on differences in the perithecia, which may be the result of habitat.

From the description and the figures (**2**, Pl. 53, Fig. 1) of

Berlese, these collections belong in *Pyrenophora ambigua* Berl. & Bres.

var. **ambigua** *stat. nov.* (FIGS. 5–6).

Perithecia larger, 175–300 μ, more depressed-globose, than in var. *Crandallii,* with both basal tomentum and apical divergent setae, usually on stems. Spores more commonly yellow-brown.

Collections: *138, 139, 140;* on herbaceous stems, from Austria and California.

The less definitely setose character of this variety may be correlated with the occurrence on stems, and the yellow-brown color of the spores with the lower altitude at which the collections were found.

var. **Crandallii** (E. & E.) comb. nov. (FIGS. 7–8, 16).

Pleospora Crandallii E. & E., Bull. Torr. Bot. Cl. **24**: 131. 1897.

Perithecia smaller, 100–200(250) μ, globose to pyriform, usually on leaves, petioles or small stems, with an apical crown of short, stout, erect pointed setae and usually no basal tomentum; spores commonly darker, red-brown.

Collections: *142, 168* (Type), *348*; on leaves or small stems, from the Alps, Sweden and Colorado.

This variety has smaller perithecia which are setose about the ostioles only and with darker spores, characters which may be due to their growth on leaves or very small stems at higher altitudes or latitudes.

The type of *Pleospora Crandallii* (*168*) is typical of this variety, having conic-globose perithecia with apical setae (FIG. 16).

The Starback collection (*142*) labelled *Pyrenophora Scleranthi* nov. sp. shows the same dark red-brown spores (FIG. 7) and small setose perithecia.

PLEOSPORA HELVETICA Niessl, Verhandl. nat. Ver. in Brünn. **15**: 191. 1876, *Figs. 10–12.*

Pyrenophora ushawaiensis Speg., in herb., inedit.?

Perithecia 150–400 μ in diameter, variously scattered, globose or usually somewhat depressed-globose, immersed at first, later slightly

erumpent, or with erumpent setae; walls rather stromatic, 20–50 μ thick, of dark colored parenchyma, often clothed below with sinuous, rather stiff, dark brown, hyphal tomentum, and bearing on the upper portion, straighter, stiffer, dark brown setose hyphae, which are usually divergent but often penetrate through the epidermis and appear on the surface as setae.

Asci clavate to broad-clavate, wall somewhat thickened, base claw-like, 80–140 × 17–24(28) μ.

Spores biseriate, oblong-ellipsoid, yellow-brown to dark red-brown, 5- to mostly 7-septate, mostly straight or slightly curved, symmetric or more often asymmetric with a narrower tapered lower portion, broadly rounded at the ends, more or less constricted at the septa, with two or three vertical septa visible in face view, 20–30 × 9–12.5(14) μ.

Collections: *141, 143, 144, 146, 148, 328, 338, 444;* on various herbaceous stems, from Tyrol, Scandinavia, Tierra del Fuego and Colorado.

This and the following species differ from the last two in the more usual presence of seven transverse septa and in the presence of more than one vertical septum in face view of the central cells. There is a continuous series of collections between this species and the two following ones. These collections are characteristic of alpine and arctic regions and represent the setose counterpart or parallel of the *P. herbarum* var. *occidentalis, P. Balsamorrhizae* and *P. coloradensis* group having perithecia without setae.

This group of collections is separated from those of the following species in a purely arbitrary manner, although they show certain correlated characters among the members of each group. The collections of this species have more flattened-globose perithecia which usually remain immersed for a longer time. The tomentum in this group consists of a flexuous basal portion and a cluster of stiffer, more seta-like hyphae on the upper walls. These stiffer hyphae are usually divergent but may penetrate through the surface as dark setae. The spores of this group are also smaller, straighter and more symmetric, in general. Those collections with no spores over 30 μ in length are arbitrarily placed here. Collection No. *144,* on grass stems, has perithecia more like those of the following species, but is placed here because of the small spores (FIG. 12).

The type of *Pyrenophora ushawaiensis* Speg. (*444*) is typical of this species, although the spores (FIG. 10) are quite small. Collections Nos. *143* and *338* have spores which are somewhat narrower than the other collections.

The descriptions of several earlier species seem to be included in the above concept. The names *P. helvetica, P. hispida, P. chrysospora,* and *P. nivalis* may be mentioned among others. These names have been used interchangeably, as may be seen from the examination of various exsiccati. The descriptions differ only in minor details such as perithecial and spore size. *P. nivalis* seems to have different, more tapered spores of the *vulgaris* type. The epithet *helvetica* is used provisionally here merely because it is the first in position among those which seem to apply. Type material must be studied to determine the proper prior binomial.

PLEOSPORA TRAGACANTHAE Rab., Hedw. **16**: 118. 1887, *Figs. 13–15.*

Pyrenophora Tragacanthae (Rab.) Sacc., Syll. Fung. **2**: 284. 1883.

Pleospora oligotricha Niessl, in Rehm, Hedw. **24**: 237. 1885.

Pyrenophora oligotricha (Niessl) Berl. & Vogl., Syll. Fung. **Add. 1–4**: 177. 1886.

Pleospora spinarum Syd., Hedw. **38**: (142). 1899.

Pyrenophora Tetraneuridis Earle, Bull. N. Y. Bot. Gard. **1904**: 294.

Pleospora glacialis Niessl, *in litt.* ad Rehm, Hedw. **24**: 236. 1885.

Pyrenophora glacialis (Niessl) Berl. & Vogl., Syll. Fung. **Add. 1–4**: 176. 1886.

Perithecia 100–400 μ in diameter, globose, slightly flattened, or conic-globose to pyriform with a conic ostiole, variously scattered, immersed at first but soon erumpent, often superficial; wall membranous or somewhat thickened, 20–40 μ thick, parenchymatic, sometimes with a slight hyphal tomentum at the base, but usually smooth below, but with a greater or lesser number of short or long, pale to dark black-brown, stiff, upright, pointed setae on the upper portion about the ostiole, either penetrating the overlying epidermis or erumpent, superficial and free.

Asci clavate to stout-clavate, thick-walled, base claw-like 95–140 × (15)24–35 μ.

Spores biseriate, oblong to clavate-ellipsoid, yellow-brown to dark red-brown or almost opaque, 7-septate, usually straight, or inequilateral, or the lower portion curved, mostly asymmetric with upper portion broader and shorter, lower portion narrower and tapered or curved, broadly rounded at the ends, constricted at the middle and slightly so or not constricted at the other septa, with two or more vertical septa visible in each central cell in face view (24)26–37 × 11–16(18) μ.

Collections: *70, 130, 136, 145, 149, 150, 151, 152* (Type), *154, 155, 347;* on herbaceous stems and leaves, from Tyrol, French Alps, Sweden, Colorado, Wyoming, Utah and Nevada.

This species is the center of a large and difficult species complex, which has apparently developed in an alpine type of habitat in various places throughout the world. On the one hand, it is related to *P. helvetica* from which it differs in the more globose or pyriform and more definitely setose rather than tomentose-setose perithecia and the larger spores. On the other hand, it is related to *P. Balsamorrhizae* with smooth perithecia (see **12**) and the *P. chlamydospora* group as discussed by Petrak (**5, 6**). The members of Petrak's collections from Iran, with setose perithecia, would fall in part in this species, although some with much larger spores might constitute another species, if they do not show the extra septa in the lower end which in turn leads to such species as *P. comata* or *P. njegusensis.*

The name *Pleospora phaeospora* (Duby) Ces. & deNot. might be chosen for this group of collections because of its priority and because Niessl's (**4**, p. 195) description of this species includes all those collections with setose perithecia, and dark, red-brown, 7-septate spores, 27–42 × 13–15 μ. He recognizes two varieties, however, on the basis of spore form, *megalospora* with long fusoid spores 36–42 × 13–15 μ, and *brachyspora* with short rhomboid-fusoid or obtuse spores, 27–31 × 13–15 μ, but also states that "Aber zwischen diesen Typen funden Ubergänge statt, welche eine strengere Scheidung sehr erschweren." In the writer's experience the fusoid type of spore figured (**4**, Fig. 20a) for var. *megalospora* is exceptional and probably abnormal. The spore range given by

Niessl would cover both this species and that given under *P. helvetica,* which is similar to his variety *brachyspora.*

Since the epithet *brachyspora* has been raised to specific rank in *Pyrenophora* by Berlese (**1**, p. 232) and in *Pleospora,* by Petrak (**5**, p. 445), and since *Pyrenophora phaeospora* is attached to the fusoid *megalospora,* it is perhaps better not to use this name here.

The name *P. Tragacanthae* was originally published without a proper description but was based on an exsiccatus, Rab., Fung. Eur. No. *2229* (*152*), from which it was described by Saccardo. It is interesting to note that the spores of this exsiccatus were given by Saccardo as 35–37 × 15–18 μ (**7**, p. 284), by Berlese (**2**, p. 40) as 28–35 × 14–17 μ, and by Petrak (**5**, 463) as 33–41 × 15.5–18 μ. The writer found them (FIG. 13) to be 30–35 × 13–15 μ. Such differences may merely mean that different samplings gave spores in different portions of a range of variation such as found in the collections in the Table.

The type (*151*) (FIG. 14) of *P. spinarum* Syd., as already stated by Petrak (**5**, p. 463), is identical with that of *P. Tragacanthae* (*152*). The type of *Pyrenophora Tetraneuridis* Earle (*P. Tetraneuris* in Sacc. Syll. **22**: 279) (*154*) has spores which are sometimes 5-septate, in which character they approach *P. helvetica,* but this may be due to immaturity, as it agrees with this species otherwise.

Pleospora glacialis Niessl & Rehm is described as having 8-septate spores which suggests that it is the same as *P. comata.* Type material (*150*), however, shows rather old, opaque or collapsed spores, but only seven septa were seen in the normal spores (FIG. 15).

Collection No. *145,* which is isotype material of *P. oligotricha,* Niessl, has rather small spores, mostly less than 30 μ long, but has perithecia characteristic of this species. This grades off through No. *144,* with still smaller spores (FIG. 12) into *P. helvetica.* Collections Nos. *149, 151,* and *154,* all show some spores with only five septa and one vertical septum in the central cells, and in this respect grade off into *P. ambigua.* Collections Nos. *139* and *347* have spores with rather bluntly tapered ends of the form of *P. vulgaris* and might be considered distinct. Nos. *70, 130,* and *152* occasionally show some spores which have the irregular septation

of the lower end, characteristic of the following species, and are again transitional individuals.

PLEOSPORA COMATA Niessl, Hedw. **12**: 122. 1873, *Figs. 18–20, 23*
Pleospora ciliata Ell., Bull. Torr. Bot. Cl. **8**: 125. 1881.
Pyrenophora ciliata (Ell.) Sacc., Syll. Fung. **2**: 285. 1883.
Pyrenophora Bornmülleri Syd., in herb., inedit.?

Perithecia 100–350 μ in diameter, scattered, globose to conic-globose, immersed at first, often soon erumpent-superficial, rather thin-walled, with a crown or fascicle of upright or slightly divergent, pointed, brown setae, 50–150 μ long, at the apex, or with more flexuous long, stiff hairs which may penetrate the epidermis.

Asci broad-clavate, thick-walled, base claw-like, 90–200 × 26–35 μ.

Spores biseriate, oblong-ellipsoid, dark yellow-brown to dark red-brown, 7–8–9-septate, straight or slightly curved, especially below, mostly asymmetric, narrower and more tapered, often curved below, ends broadly rounded, constricted at the middle and sometimes at the other septa, regularly 7-septate, or often with irregular oblique septa in the lower end or with one or two extra tertiary septa, 28–50 × 13–18 μ.

Collections: *123, 153, 156, 157, 158, 301;* on herbaceous stems and leaves, from Turkestan, Tierra del Fuego, Montana, Nevada, Washington and Wyoming.

This is probably a somewhat artificial species erected to accommodate those collections with spores 30–50 μ long and which show the irregular or extra septation in the lower end. Such septation occurs in one or two spores in some other collections, such as Nos. *70, 130,* and *152* of the previous species. The perithecia are not always setose; in collection No. *123,* for instance the perithecia on the petals are setose, whereas those on the pedicels are not.

There seems to be no type of *P. ciliata* in existence, but three collections (*153, 156, 158*) in the Ellis collections of the New York Botanic Garden, all show small apically setose perithecia (FIG. 20) and spores (FIG. 18) with the characteristic irregular septation Collection No. *157,* from the Bornmüller herbarium, labelled *Pyrenophora Bornmülleri* Syd. has these same spores (FIG. 19), but

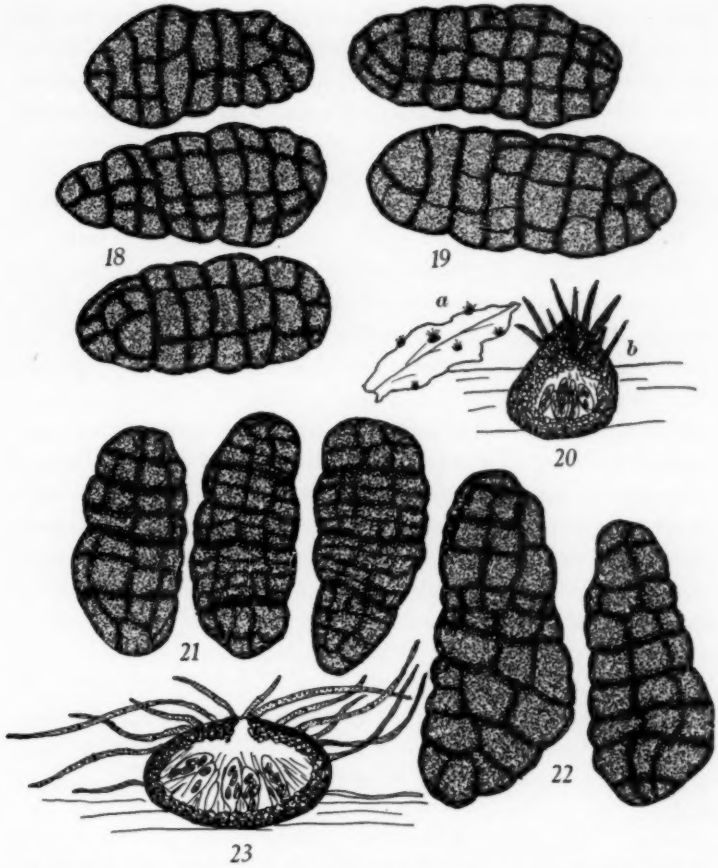


FIG. 18. Spores from a collection (*153*) of *Pleospora ciliata* Ell. 19. Spores from a collection (*157*) labelled *Pyrenophora Bornmülleri* Syd. 20. Habit (a) and vertical section of a perithecium (b) of a collection (*153*) of *Pleospora ciliata* Ell. 21. Spores from the type collection (*313*) of *Pleospora abbreviata* Fck. 22. Spores from the type collection (*504*) of *Pleospora kouh-sefidica* Frag. 23. Vertical section of a perithecium from collection No. *157* of *Pyrenophora Bornmülleri* Syd., inedit.

the perithecia (FIG. 23) are more flattened and have long flexuous setae.

The name *P. comata* is used here provisionally. The spores were originally (**3**, p. 122) described merely as "muriform."

Later (**4**, p. 194) Niessl states that they are at first 7–9- and then 11–13- (or more) septate. This suggests *P. abbreviata*. Berlese gives the spores as 8–11-septate, but his figures (**2**, Pl. 62, Fig. 2) show them nearly all 8-septate, with the extra septum, however, in the upper half of the spore.

PLEOSPORA KOUH-SEFIDICA Frag., Bol. Roy. Soc. Espan. Hist. nat. **18**: 81. 1918, *Fig. 22.*

Perithecia 200–250 μ in diameter, globose, immersed, soon erumpent, scattered, with or without an apical crown of divergent, dark-brown, stiff, rather short spines; wall membranous.

Asci stout clavate, thick-walled, base stout claw-like, 100–140 $\times$ 50–60 μ.

Spores biseriate to triseriate, oblong-ellipsoid, dark yellow-brown to dark red-brown, 7-septate, or more often 8- or 9-septate, mostly inequilateral, with one side flattened, asymmetric, lower end narrower and more tapered, more or less constricted at all septa, ends broadly rounded, regularly 7-septate or with irregular oblique septa in the lower end, or with tertiary septa in the end or penultimate secondary cells, 44–48 $\times$ 17–19.5 μ.

Collections: *504* (Type); on *Astragalus*, from Persia.

The type collection of this species differs from the collections placed in *P. Tragacanthae* in the common occurrence of the irregular or extra septa in the lower end of the spore, and from those placed in *P. comata* in the larger spores. It is therefore, kept separate.

PLEOSPORA ABBREVIATA Fck., Reise nach Nordpolar. III & in Oud. Contr. Fung. Myc. Now. Sembla 152, *Fig. 21.*

Perithecia 200–250 μ in diameter, globose to pyriform, immersed, appearing as minute dots on dead leaves; walls membranous, with a small cluster of short, stout, dark brown spines at the apex about the ostiole in young perithecia.

Asci clavate, thick-walled, base claw-like, 140 $\times$ 28–30 μ.

Spores biseriate, oblong-ellipsoid, dark yellow-brown to red-brown, 5- to 7-septate at first, many-septate (11–15) at maturity, straight, inequilateral or slightly curved, mostly asymmetric, broader above, narrower and tapered below, constricted at the central

septum, rarely so at the other septa, ends broadly rounded, tardily septate; three primary septa thicker than the four secondary septa; tertiary septa laid down in any cell to form a many-septate spore; septa often oblique in lower end, 33–37.5 × 13–16 μ.

Collection: *313* (Isotype); on *Phaca*, from Nova Zembla.

The collection (*313*) examined is a portion of the original collection. There are some discrepancies between the description and the *Pleospora* found on this material. The perithecia seen were on leaves, not sepals or legumes and both spores and asci were somewhat larger than given in the original description. It is probably the same fungus, however. The spores of this collection differ from the other setose forms in the insertion of tertiary septa in an irregular and tardy fashion in any of the cells of a spore in the 7-septate condition, resulting in spores with variable septation. Young spores show the three primary septa as thick walls, followed by the four secondary septa, which are usually definitely thinner and less prominent. The 5-septate spores mentioned in the original description were probably immature ones. The septa in the lower end of the spore in the 7-septate condition may be laid down irregularly at oblique angles, as in *P. comata*.

LITERATURE CITED

1. **Berlese, A. N.** Monografia dei generi *Pleospora, Clathrospora* e *Pyrenophora*. Nuovo Giorn. bot. ital. **20**: 1–260. 1888.
2. ——. Icones Fungorum 2. Pyrenomycetes. Patavii. 1900.
3. **Niessl, G. v.** Beiträge zur Kenntnis der Pilze. Hedw. **12**: 115–123. 1873.
4. ——. Notizen über neue und kritische Pyrenomyceten. Verhandl. naturf. Ver. Brünn. **14**: 165–218. 1876.
5. **Petrak, F.** Fungi. In Rechinger, K. H., Ergebnisse einer botanischen Reise nach dem Iran, 1937. Ann. naturhist. Mus. Wien **50**: 410–536. 1940.
6. ——. Beiträge zur Kenntnis der orientalischen Pilzflora. Ann. naturhist. Mus. Wien **52**: 301–396. 1942.
7. **Saccardo, P. A.** Sylloge Fungorum. 2. Pyrenomyceteae. 1883. Patavii.
8. ——. Fungorum extra-Europaeorum. Michelia **2**: 136–149. 1880.
9. **Wehmeyer, L. E.** Studies on some fungi of northwestern Wyoming. III. Pleospora and Leptosphaeria. Lloydia **9**: 203–240. 1946.
10. ——. The developmental pattern within the genus Pleospora Rab. Mycologia **40**: 269–294. 1948.
11. Studies in the genus Pleospora. I. Mycologia **41**: 565–593. 1949.
12. ——. Studies in the genus Pleospora. II. Lloydia (in press).

SPECIMENS EXAMINED

70—*Pleospora Tragacanthae* Rab., on *Phaca frigida*, Furstenalp, Graubunden, 1800 m., Aug. 15, 1903, leg. A. Volkart. (Riksmuseet: Rehm Asc. 1566).

123—*Pleospora herbarum* (Fr.) Rab., on *Ranunculus*, Isla de los Estados, Tierra del Fuego (La Plata Mus. 7146).

130—*Pyrenophora comata* (Niessl) Sacc., on *Silene Hallii*, Ruxton Dell, Colo., 2700 m., Aug. 10, 1905 (Farl.: Clem. Crypt. Form. Colo. 38).

136—*Pyrenophora Tetraneuris* Earle, on *Zygadenus alpina*, Skyline Trail, Teton Nat. Park, Wyo., July 24, 1940 (Wehm. Herb. 1176).

137—*Pyrenophora helvetica* (Niessl) Sacc., on *Tofieldia palustris*, Suecica: Lapponica, Lulensis, 29/6-8/7/1901, leg. T. Vestergren, det. Rehm (Riksmuseet: Vestergr. micr. rar. sel. 522).

138—Undetermined, on *Lupinus albicaulis* var. *shastensis*, Mt. Shasta, Calif., Aug. 18, 1941, leg. W. B. Cooke No. 15739 (Wehm. Herb.).

139—Undetermined, on *Aster shastensis*, Mt. Shasta, Calif., July 12, 1946, W. B. Cooke No. 18234 (Wehm. Herb.).

140—*Pyrenophora ambigua* Berl. & Bres., on *Telekia* sp., im Garten, Triglitz, bei Prignitz, Mar. 7, 1910, leg. O. Jaap. (Riksmuseet: Herb. Rehm No. 768).

141—*Pyrenophora hispida* Niessl var. *alpina* Rehm, on *Compositc* stem, Franzenhohe, Tyrol, July 1884, leg. Rehm (Riksmuseet: Herb. Rehm) (Type of var.).

141a—Same data; second fungus.

142—*Pyrenophora Scleranthi* Starb. inedit. on *Scleranthus*, Suecica: Aplandia, Uppsala, Flottsund, Aug. 1892, leg. H. Starback. (Riksmuseet).

143—*Pleospora helvetica* Niessl, on plant stem, Moräne, des Sulden Gletscher Ortler, July 1884, leg. Rehm (Riksmuseet: Herb. Rehm).

144—*Pyrenophora hispida* Niessl, on grass stems, Franzenshohe, July 1884, leg. (Riksmuseet: Herb. Rehm).

145—*Pleospora oligotricha* Niessl. on *Trifolium pallescens*, Moräne des Sulden Gletschers am Ortler (Tyrol) 2700 m., July 1884, Dr. Rehm (Riksmuseet: Rehm Asc. No. 830) (Isotype).

146—*Pyrenophora hispida* Niessl; var. *alpina* Rehm, on *Umbellifer*, ———?, July 1888, leg. Rehm (Riksmuseet: Herb. Rehm).

148—*Pleospora helvetica* Niessl, on *Phyteuma*, bei Mettlberg in Pizthal (Tyrol), Aug., 1875. leg. Rehm (Riksmuseet: Herb. Rehm).

149—*Pyrenophora* (*oligotricha*?), on *Artemisia rupestris*, Gottland: Bro, July 23, 1913, T. Vestergren. (Riksmuseet: Fl. Suec.).

150—*Pleospora glacialis* Niessl & Rehm, on *Cerastium latifolium*, Sulden Gletschers am Ortler (Tyrol), July 1884, leg. Rehm (Riksmuseet: Rehm Asc. No. 829 (Isotype).

151—*Pleospora spinarum* Syd., on *Astragalus aristata*, Basses Alpes, Larche, July 2, 1893, leg. G. Vidal (Riksmuseet: Herb. Sydow) (Type).

152—*Pleospora Tragacanthae* Rab., on *Astragalus Tragacanthus*, Monte Cenis, July 1876, leg. C. E. Broome. (Riksmuseet: Rab. Fung. Eur. 2229) (Isotype).

153—*Pyrenophora ciliata* (Ell.) Sacc., on *Frasera speciosa*, Deer Lodge,

Mont., June, 1888, leg. F. D. Kelsey (N.Y.B.G.: Anderson Par. Fung. Mont. 415).

154—*Pyrenophora Tetraneuris* Earle, on *Tetraneuris*, Kings Canyon, Carson, Nev., June 14, 1902, leg. C. F. Baker. (N.Y.B.G.: 1068) (Type).

155—*Pleospora Tragacanthae* Rab., on *Astragalus aristatus*, Lohweiss, Findelen, 6, Zermatt, July 27, 1905, leg. O. Jaap. (Riksmuseet: Herb. Rehm 455).

156—*Pleospora ciliata* Ell., on *Phlox Douglasii*, Mt. Paddo, Wash. Terr., Aug. 1885, leg. W. N. Suksdorf No. 195 (N.Y.B.G.: 21b).

157—*Pyrenophora Bornmülleri* Syd. inedit., on *Cousinia lactivirens*, Sarawsihar, Sary-dagh, July 23, 1913, leg. J. Bornmüller (Riksmuseet: Herb. Bornmüller: Fl. Turkestanica).

158—*Pyrenophora ciliata* (Ell.) Sacc., on *Phlox*, Kings Canyon, Ormsby Co., Nev., June 1, 1912, leg. C. F. Baker No. 910 (N.Y.B.G.).

168—*Pleospora Crandallii* E. & E., on *Androsace Chamarjasme*, Cameron Pass, Colo., July 6, 1894, leg. C. S. Crandall. (N.Y.B.G., 2 pkts.: Ellis coll. 237) (Type).

301—*Pleospora njegusensis* Bub., on *Balsamorrhiza sagittata*, Camp Davis, Jackson, Wyo., June 26, 1940 (Wehm. Herb. 1063a).

313—*Pleospora abbreviata* Fck., on *Phaca rigida*, Nowaja Sembla. (Riksmuseet: Herb. Sydow, marked "original") (Isotype).

326—(*Pyrenophora?*), on *Solidago Virgaureae*, Suecica: Ad. (Storlien) Jemtlandiae, July 6, 1932, leg. A. G. Eliasson (Riksmuseet).

327—Variously labelled, on grass (leaves), Zermatt, Sept., '95, March, '96, leg. Wegelin (Riksmuseet).

328—(*Pyrenophora*), on *Barbarea stricta*, Suecia: ad (Storlien) Jemtlandiae, June 22, 1932, leg. A. G. Eliasson (Riksmuseet).

338—(*Pyrenophora*), on *Potentilla verna*, Lule Lapmark, Sarek: Lullewage, July 9, 1900, T. Vestergren (Riksmuseet).

340—Undetermined, on *Braya glabella*, Torne Lappmark: Jukkasjarvi s:n, Sjangeli, Ruojisuols, Aug. 16, 1936, leg. Rolf Santesson (Riksmuseet: Fl. Suec.).

347—(*Pleospora*), on *Arenaria uintahensis*, Wasatch Mts., Salt Lake City, Utah, June 7, 1904, leg. A. O. Garrett (Riksmuseet: Herb. Sydow).

348—*Pleospora pyrenaica* Niessl, on *Arabis pumila*, Albula Pass, Rhetiae, Aug., 1882, leg. G. Winter (Riksmuseet: Rab. Fung. Eur. 2855).

444—*Pyrenophora ushawaicnsis* Speg., on *Senecio longipes*, Ushuwaia, Tierra del Fuego, Jan. 1924 (La Plata Mus. No. 2195) (Type).

504—*Pleospora kouh-scfidica* Frag., on spines of *Astragalus rhodosemii*, prope Kouh-Sefid (Persiae), VI-1899, leg. Escalera. (Herb. Jard. Bot. Madrid: Fung. No. 2710) (Type).

STUDIES OF NORTH AMERICAN THELEPHORACEAE. I. SOME NEW WESTERN SPECIES OF PENIOPHORA [1]

H. S. Jackson and Elizabeth Ruth Dearden [2]

(with 6 figures)

In connection with a general study of resupinate Thelephoraceae of North America a number of apparently undescribed species have been encountered. Following are descriptions and illustrations, with comments, of six species of *Peniophora* from western United States which are proposed as new.

Peniophora involuta sp. nov. (Fig. 1)

Fructificatio delicata, tenuis; subiculum obscurum, paulum amplificatum, hyphis plerumque obscuris, tenuiter tunicatis, nodoso-septatis; cystidia fusoideo-subulata, 50–70 × 7–8 μ, apice obtuso; basidia cylindracea, interdum infra ventricosa; 15–16 × 5.5–6 μ, quattuor subulata sterigmata gerentia; basidiosporae ellipsoideae, 5–6.5 × 3–4 μ, tunicis tenuibus, levibus, non-amyloideis.

Fructification delicate, pallid, very thin, minutely reticulate under a lens; subiculum obscure, poorly developed, hyphae with thin walls and clamps at the septa, for the most part collapsed and indistinct; cystidia fusoid-subulate, tapering to an obtuse apex, 50–70 × 7–8 μ; basidia cylindrical, occasionally somewhat ventricose below, 15–16 × 5.5–6 μ, bearing four subulate upright sterigmata; basidiospores ellipsoid, laterally compressed, with prominent apiculus, 5–6.5 × 3–4 μ, walls thin, smooth, non-amyloid.

Specimen examined: **Wyoming**: On rotting coniferous wood, South Brush Creek camp ground, Medicine Bow Nat. Forest, July 25, 1942, S. M. Pady, **type**.

[1] Contribution from the Department of Botany, University of Toronto, Toronto, Ontario. This study was carried out with the assistance of a grant in aid of research furnished by the University of Toronto.

[2] The writers are greatly indebted to the collectors of the specimens on which the species here described are based, and to Miss Margaret H. Thomson for preparing the Latin diagnoses.

This species would have been placed by Bourdot & Galzin in their section "Gloeocystidiales" of *Peniophora*. This section, as conceived by them, included, in three subsections, a series of species having thin-walled, non-incrusted cystidia which project considerably above the surface of the hymenium and were considered to be readily distinguishable from typical gloeocystidia. This general concept resulted in bringing together, in this section, a heterogeneous assembly of species most of which are obviously unrelated. It is difficult to imagine, for example, any close relationship between *Peniophora argillacea* (Bres.) Sacc. & Syd., *P. chordalis* Höhn. & Litsch. and *P. vilis* B. & G.

The closest relative of *P. argillacea* among described species is *Gloeocystidium macedonicum* Litsch.; *P. clavigera* Bres., *P. orphanella* B. & G. and *P. orphanella* subsp. *pinastri* Bourd. & L. Maire appear to possess certain features in common which may indicate close relationship. All have a rather thin fructification, a membranous or submembranous texture and non-encrusted cystidia with thin walls or with walls tending to become slightly thickened below. Apparent relatives of this group include *P. medioburiensis* Burt, *P. amoena* Burt and the species described above.

P. involuta is readily distinguished from all others by the uniformly thin-walled subulate cystidia and the relatively small spores.

Peniophora assimilis sp. nov. (FIG. 2)

Fructificatio irregulariter effusa, alba, submembranacea, interdum rimosa; subiculum obscurum, hyphis tenuiter tunicatis, nodoso-septatis; cystidia cylindracea, 55–80 × 6–8.5 μ, interdum infra ventricosa, apice capitato, 9–11 μ lato, tunicis tenuibus, interdum infra tenuiter incrassatis; basidia clavata, 38–54 × 7–8.5 μ, quattuor sterigmata gerentia; basidiosporae cylindraceae, 13–15 × 4.5–5.5 μ, tunicis levibus, tenuibus, non-amyloideis.

Fructification irregularly effused, white or pale cream, soft, submembranous, smooth, becoming occasionally deeply rimose, margin thinning out; subiculum for the most part indistinct, made up of thin-walled hyphae with clamps which soon become collapsed, interspersed with abundant crystalline material; cystidia cylindrical, 55–80 × 6–8.5 μ, occasionally slightly ventricose below, apex capitate, 9–11 μ broad, walls thin, occasionally in age becoming slightly thickened below; basidia clavate, 38–54 × 7–8.5 μ, occasionally subventricose, with four stout arcuate or slightly divergent sterigmata, 7.5–8.5 μ long; basidiospores cylindrical, 13–15 × 4.5–5.5 μ, slightly

flattened on inner side with minute lateral apiculus, walls smooth, thin, non-amyloid.

Specimen examined: **California:** On wood and bark of *Purshia tridentata,* Military Pass Road, S. of Andesite Sta., N. side Mt. Shasta, Apr. 9, 1947, W. B. Cooke *19412,* **type.**

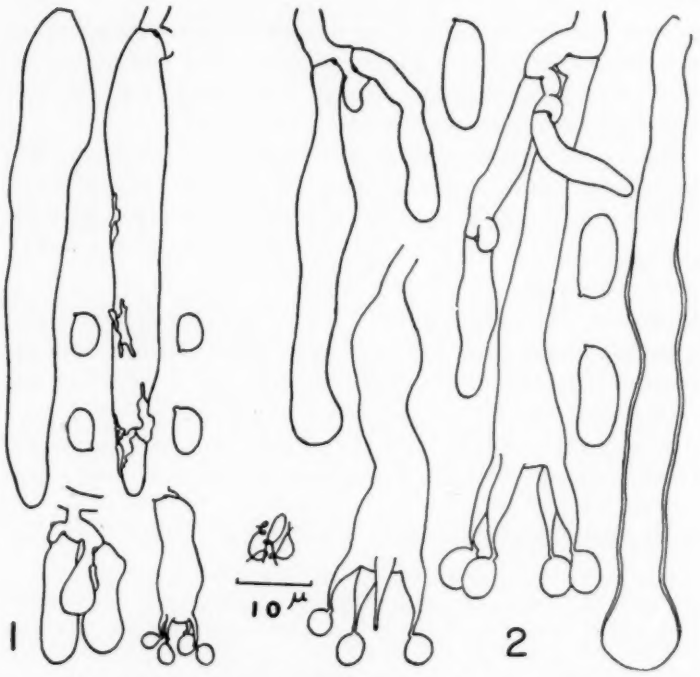


FIG. 1. *Peniophora involuta;* FIG. 2. *Peniophora assimilis.* (Reproduced at a magnification of approximately × 1000.)

The species described above is also a member of Bourdot & Galzin's section Gloeocystidiales.

In the morphology of basidia and spores *P. assimilis* shows strong affinities with *P. amoena* Burt and *P. medioburiensis* Burt. All three species have distinctive cystidia; in *P. assimilis* they are cylindrical, subventricose and capitate with a tendency toward thickened walls; in *P. amoena,* narrowly fusoid and with slightly

thickened walls; in *P. medioburiensis* the cystidia are uniformly cylindrical and thin-walled.

Peniophora regifica sp. nov. (FIG. 3)

Fructificatio late effusa, alba, tenuiter ceracea vel submembranacea; subiculum inferius e plus minusve paralleliter currentibus hyphis, tunicis gelatineis, compositum, stratura subhymenialis e laxe ramosis subrectis nodoso-septatis hyphis composita; cystidia numerosa, cylindracea, 100–150 × 7.5–8.5 μ, apice subgloboso, 10–12 μ lato, tunicis apicalibus exceptis incrassatis; basidia late clavata vel cylindracea, 18–22 × 6.5–7 μ, quattuor 6–8 μ longa sterigmata gerentia; basidiosporae late ellipsoideae, 7–8.5 × 4.5–5.5 μ, tunicis tenuibus, levibus, non-amyloideis.

Fructification white, widely effused, thin, 50–170 μ, adnate, ceraceous to submembranous, under a lens appearing somewhat tufted and hispid due to emergent cystidia; margin thinning out abruptly; lower subiculum forming a narrow basal layer of more or less horizontal hyphae with gelatinized walls, the subhymenial layer of loosely branched suberect thin-walled hyphae with clamps at the septa, becoming collapsed and indistinct; cystidia numerous, cylindrical except for the inflated subglobose or obovate apex, 100–150 × 7.5–8.5 μ, apex 10–12 μ broad, walls thick except for the expanded apex, dissolving in KOH, lumen capillary, abruptly dilated below the apex, light incrustation may be present on the dilated portion; basidia broadly clavate or cylindrical, 18–22 × 6.5–7 μ, with 4 slender, subulate, straight sterigmata 6–8 μ long; basidiospores broadly ellipsoid, 7–8.5 × 4.5–5.5 μ, laterally flattened with minute apiculus, walls thin, smooth, non-amyloid.

Specimen examined: **Oregon**: On coniferous wood, Peavy arboretum, Benton Co., Oregon, Nov. 11, 1940, M. Doty, *5236*, **type**.

This species is obviously a member of the subsection * * * of Bourdot & Galzin's section Tubuliferae of the genus *Peniophora*. The capitate cystidia suggest relationship with *P. juniperina* B. & G. and *P. accedens* B. & G. from which it is clearly different in several characters, notably the relatively large ellipsoid spores, and much larger cystidia.

Peniophora prominens. (FIG. 4)

Fructificatio delicata, mucida, alba, laxe aggregatas floccosasque cristas gignens, sub lente delicate hispida; hyphae basales paucae, paralleliter currentes, subiculum distinctum non producentes, nodoso-septatae, ramis rectis apicem versus cristas basidiarum cystidiis raris interspersarum producentibus;

cystidia numerosa, cylindracea, 80–100 × 4–4.5 μ, supra in coni figuram apice obtuso assurgentia, tunicis infra incrassatis, lumine infra capillari; basidia cylindracea vel supra inflata, 15–17 × 4.5–5 μ, quattuor sterigmata gerentia, tunicis infra incrassatis; basidiosporae subglobosae, apiculo prominente, 3.5–4 × 4 μ, tunicis tenuibus, levibus, non-amyloideis.

Fructification delicate, mucedinous, white, discontinuous, formed of loosely aggregated floccose tufts, delicately hispid under a lens due to projecting cystidia, margin not differentiated; basal hyphae few, more or less horizontal, with clamps, not forming a distinct subiculum, giving rise at intervals to upright branches terminated by clusters of basidia with scattered cystidia; cystidia numerous, cylindrical or slightly tapering above, 80–110 × 4–4.5 μ, obtuse at apex, walls thickened below, gradually thinning out toward apex, more or less soluble in KOH, non-amyloid, lumen capillary at base, gradually expanding above, thin-walled in the upper third; basidia cylindrical or somewhat inflated above, 15–17 × 4.5–5 μ, bearing four subulate, slightly arcuate sterigmata, walls thickened below, after maturity clusters of basidial bases remain as stalked cyathiform structures with thick rigid walls, proliferation of basidia is acropetal through subtending clamps, giving rise to branched clusters of basidia frequently centering around a cystidium; spores subglobose, 3.5–4 × 4 μ, with conspicuous lateral peg-like apiculus, walls thin, smooth, non-amyloid.

Specimen examined: **Idaho**: On rotting wood of *Pinus monticola*, N. of junction between highway and trail 246, Bonner Co., June 12, 1940, A. W. Slipp, U. of Idaho, For. Path. Herb. *2418*, **type**.

This species is also a member of the subsection * * * of the section Tubuliferae of the Bourdot & Galzin classification. It differs from all members of that group except *P. farinacea* in the possession of subglobose spores. From the latter it differs in the character of the fructifications, the cystidia and basidia. In most of the members of this subsection the thickened walls of the cystidia are soluble in KOH.

Peniophora munda sp. nov. (FIG. 5)

Fructificatio alba, late diffusa, membranaceo-pelliculosa; subiculum e tenuiter trunicatis, 1–2 μ latis, laxe intertextis, nodoso-septatis hyphis compositum; cystidia cylindracea vel anguste obclavata, 25–45 × 2.5–3.5 μ, tenuiter tunicata, non-incrustata; basidia cylindracea vel subclavata, 6–8 × 3–4 μ, quattuor gracilia sterigmata gerentia; basidiosporae 3–4 × 1.5–2 μ, tunicis tenuibus, levibus, non-amyloideis.

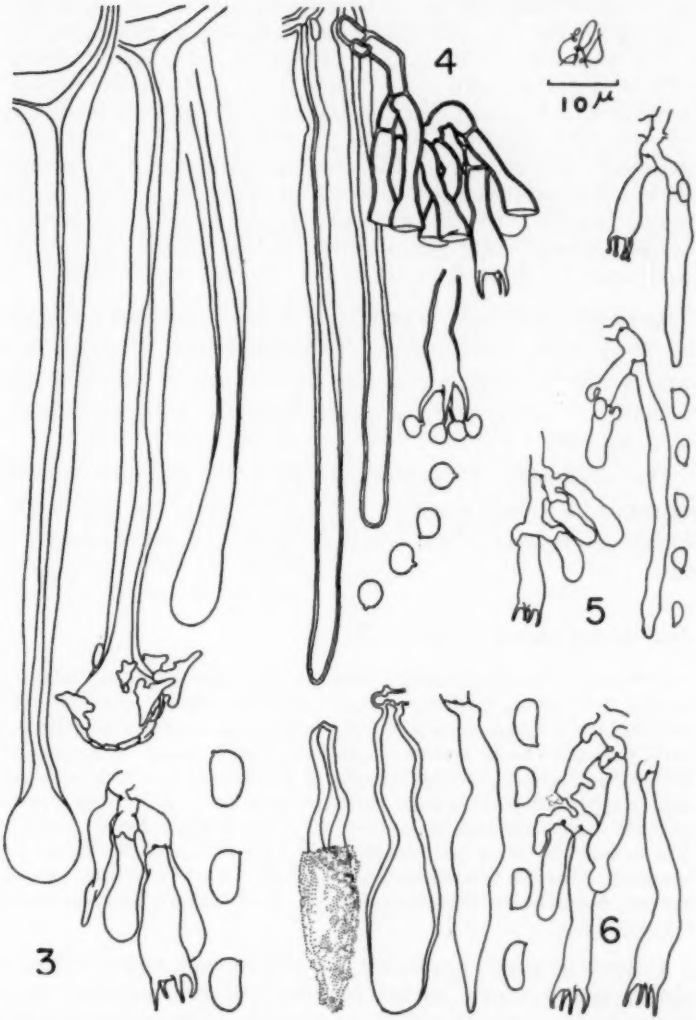


FIG. 3. *Peniophora regifica;* FIG. 4. *Peniophora prominens;* FIG. 5. *Peniophora munda;* FIG. 6. *Peniophora exima.* (Reproduced at a magnification of approximately × 1000.)

Fructification white, extensive, irregularly effused over the surface of substratum, soft membranous-pelliculose, margin gradually thinning out, not especially differentiated; subiculum loose, made up of fine horizontal or irregularly interwoven, thin-walled hyphae 1–2 μ in diameter, with clamp connections, walls usually heavily incrusted with crystals; cystidia cylindrical or narrowly obclavate, somewhat flexuous, 25–45 × 2.5–3.5 μ, with thin walls, unincrusted, extending two-thirds their length above the hymenium; basidia cylindrical to subclavate, 6–8 × 3–4 μ, developed from subhymenial hyphae in cymose clusters through progressive proliferation from clamps, bearing 4 upright, slender, slightly arcuate sterigmata; basidiospores 3–4 × 1.5–2 μ, walls thin, smooth, non-amyloid.

Specimens examined: **Wyoming:** On *Picea engelmannii*, decaying wood inside rotting stump, Headquarters park, Medicine Bow Mts. at 9600 ft., Carbon Co., July 16, 1942, W. G. and Ragnhild Solheim *2034, 2035*, **type**; same data, inside crevices of fallen coniferous log *2044*.

The relationship of this delicate species is not clear. In gross appearance it closely resembles some members of the section Pellicularia of the genus *Corticium* in the Bourdot & Galzin classification.

Peniophora exima sp. nov. (FIG. 6)

Fructificatio late effusa, pallide roseo-ochracea, dein maturitate ochracea, ceracea, dein rimosa, 120–200 μ crassa; subiculum obscure stratosum, infra aureo-fuscum, e hyphis infra intertextis collapsisque, sed supra plus minusve rectis, nodulosis, nodoso-septatis compositum; cystidia numerosa, apice acuto, 40–50 × 10–12 μ, levi et dense tunicata et e subhymenio orta parti basali, apice graviter incrustato et super hymenium emergente; cystidia (aut gloeocystidia) tenuiter tunicata, acuta, 50–60 × 7.5–9 μ quoque praesunt; gloeocystidia cylindracea, supra late obtusa, 45–55 × 8.5–10 μ, ultra hymenium non emergentia; basidia cylindraceo-flexuosa, 25–35 × 3.5–4.5 μ, quattuor sterigmatibus; basidiosporae ellipsoideae, 5.5–6.5 × 2.5–3 μ, tunicis tenuibus, levibus, non-amyloideis.

Fructification widely effused, pale pinkish buff, fading to buff in age, ceraceous, adnate, surface continuous at first becoming deeply rimose in age, 120–200 μ thick, margin not differentiated, thinning out abruptly; subiculum becoming indistinctly stratose, golden brown below, colorless above, made up of closely interwoven hyphae below which become collapsed and obscure in age, hyphae more or less upright above, somewhat nodulose, with clamps at the septa; cystidia numerous, thick-walled, pointed above, heavily incrusted,

with a smooth, thick-walled, often slightly colored stalk-like base, 40–50 × 10–12 μ, having their origin in the subhymenium with the incrusted cap extending above the level of the hymenium; thin-walled unincrusted pointed cystidia (or gloeocystidia?), 50–60 × 7.5–9 μ, also present which extend above the hymenium; gloeocystidia cylindrical, broadly obtuse above, 45–55 × 8.5–10 μ, imbedded or reaching the level of the hymenium, often with walls thickened laterally, remaining thin apically; basidia cylindrical-flexuous, 25–35 × 3.5–4.5 μ, bearing 4 straight sterigmata 4 μ long; basidiospores ellipsoid, laterally compressed and nearly straight on one side, with lateral apiculus, 5.5–6.5 × 2.5–3 μ, walls thin, smooth, non-amyloid.

Specimens examined: **California**: On *Abies magnifica* var. *shastensis*, hand hewn boards, Horse Camp, 8000 ft. Mt. Shasta, June 24, 1948, W. B. Cooke *18033*; same data on old bench log *18034*, **type**.

Distinctive because of the combination of characters, this species may prove to be related to *P. pubera* (Fr.) Sacc. and *P. guttulifera* (Karst.) Sacc.

DEPARTMENT OF BOTANY,
UNIVERSITY OF TORONTO,
TORONTO, CANADA

TWO NEW FUNGI ON TORREYA

LEE BONAR

(WITH 5 FIGURES)

Torreya californica Torr., the California nutmeg, is a species that is remarkably free of recorded fungus parasites. Recent collections of two undescribed species have been made. I am grateful to Mr. J. W. Duffield, Institute of Forest Genetics, Placerville, California, for sending in the original collection of the rust and assisting in later field work.

Caeoma Torreyae sp. nov.

Spermogonia amphigena, diffusa, subepidermalia, subglobosa, paraphysata, 100–130 μ lata × 130–185 μ alta. In folia cum aut sine aeciis.

Aecia hypophylla, usitata confluenta, lineas albidas, occasione lineas interruptas efformantia; subepidermalia, erumpentia, ad 3 cm. longa × 0.5–0.7 mm. lata. Peridia nulla. Aeciosporae late ellipsoidae vel globosae, subangulares, 9–12 × 15–20(25) μ; membrana subtiliter verruculosa, hyalina, 1–1.5 μ cr.

In foliis *Torreyae californicae.*

Spermogonia amphigenous, scattered, subepidermal, subglobose, paraphysate, 100–130 μ wide, 130–185 μ high. In leaves, with or without aecia.

Aecia hypophyllous, usually confluent forming white lines, occasionally interrupted lines. Subepidermal, erumpent, up to 3 cm. long by 0.5–0.7 mm. wide. Peridium lacking. Aeciospores broadly ellipsoid to globoid, subangular, 9–12 × 15–20(25) μ, wall finely verrucose, colorless, 1–1.5 μ thick.

Infected leaves chlorotic, to greenish-brown, averaging 1.8–2 mm. in thickness, while normal leaves average 0.6–0.7 mm. in thickness.

On leaves of *Torreya californica* Torr. in California. Eldorado County: Chute Camp Road, Iowa Canyon, Nov. 9, 1948, J. W. Duffield and N. T. Mirov; Nov. 18, 1948, J. W. Duffield and Lee Bonar (**type**); Sept. 6, 1949, Lee Bonar. North Canyon Creek, Sept. 7, 1949, Lee Bonar. Santa Cruz County: Big Creek fire

station, Sept. 18, 1949, J. W. Duffield; Oct. 29, 1949, Lee Bonar. Marin County: Near summit of Mount Tamalpais, Oct. 1, 1949, Lee Bonar. Mendocino County: 5½ miles west of Willetts, Dec. 29, 1949, J. W. Duffield.

Infection occasional to abundant on current season's leaves; more abundant on young plants. Infected leaves fall while normal ones remain on tree for three to four years.

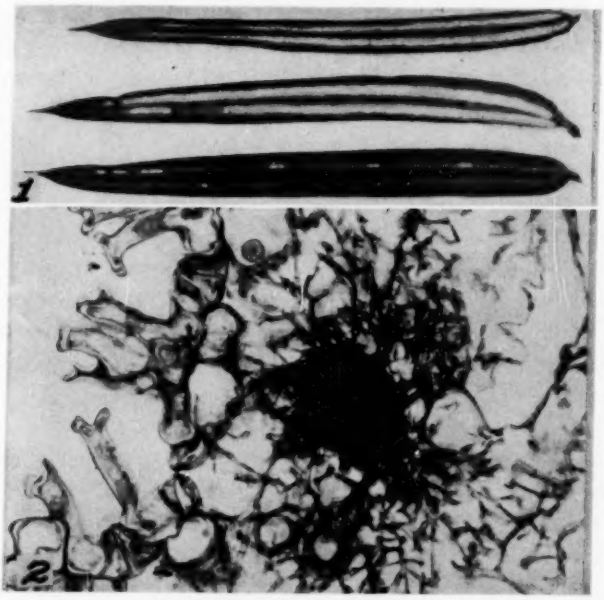


FIG. 1. Habit on needles, spermogonia and aecia, × 2.5. FIG. 2. Aecial primordium. × 300.

The two white lines formed on each leaf by the caeomoid aecia are especially distinctive in this rust (FIG. 1).

Rust infections on members of the Taxaceae are very rare, this being the first that I have found recorded for North America.

Many uninfected leaves at the type locality showed heavy attack by the pine leaf scale, *Phenacapsis pinifoliae* (Fitch), while those infected by the rust were with rare exceptions entirely free of the insects.

No indications have as yet been found of a possible alternate host for this rust.

The development of the aecia in this species may be followed in sections of the leaves collected from September to November. Aecia are initiated by a massing of hyphae between leaf cells immediately above the first row of mesophyll cells and internal from the two lines on the lower side of the leaf which are depressions bearing the sunken stomata (FIG. 2). The hyphal mass increases and becomes more compact. Certain cells near the outer margin of the mass enlarge, lose their contents and become the first distinguishable buffer cells. With the continued increase in the mass of the primordium more buffer cells are formed toward the surface of the leaf. A dome-shaped mass of buffer cells 8–12 cells thick covered by a delicate layer of unmodified hyphal cells is formed (FIG. 3). The aeciospore chain initials form a palisade internal to the buffer cells and cause an expansion of the whole primordium. The pressure from the expanding aecium compresses and obliterates the covering mesophyll cells as well as the outer layers of the buffer cells (FIG. 4). The developing aecia finally fill the entire length of the stomatal grooves of the leaf. The epidermis breaks and the edges are reflexed exposing two white lines of aeciospores on each leaf (FIG. 5).

The sides of the aecia are lined by a hyphal felt, thick toward the base and tapering to 1–2 cells in thickness at the outer edge. The cells on the inner surface of this felt become enlarged and at times resemble a peridial layer. They are irregular in size and arrangement, however, and develop from the hyphal felt instead of from the aeciospore initials as do true peridial cells in the cupulate type of aecium.

Clasterosporium obclavatum sp. nov.

Hyphis superficialibus, extenuatis, fuligineis, hypophyllis, in maculis, deinde confluentibus et totam inferiorem superficiem foliorum occupantis: in reticulum anastomosantibus; 3–5 μ cr., levibus ad torulosis cum glaebis nodosis chlamydosporum numerosis et inaequalibus. Conidiophoris solitariis, simplicibus, fuscis, 5–9 μ longis, 1–2 cellularibus. Conidiis solitaris, acrogenis, abrupte obclavatis, fuscis, ad apicem attenuatis et pallidis fuscescentibus; 5–13-septatis, ad septa constrictis, 8.5–12 × 54–72 μ.

In foliis *Torreyae californicae*.

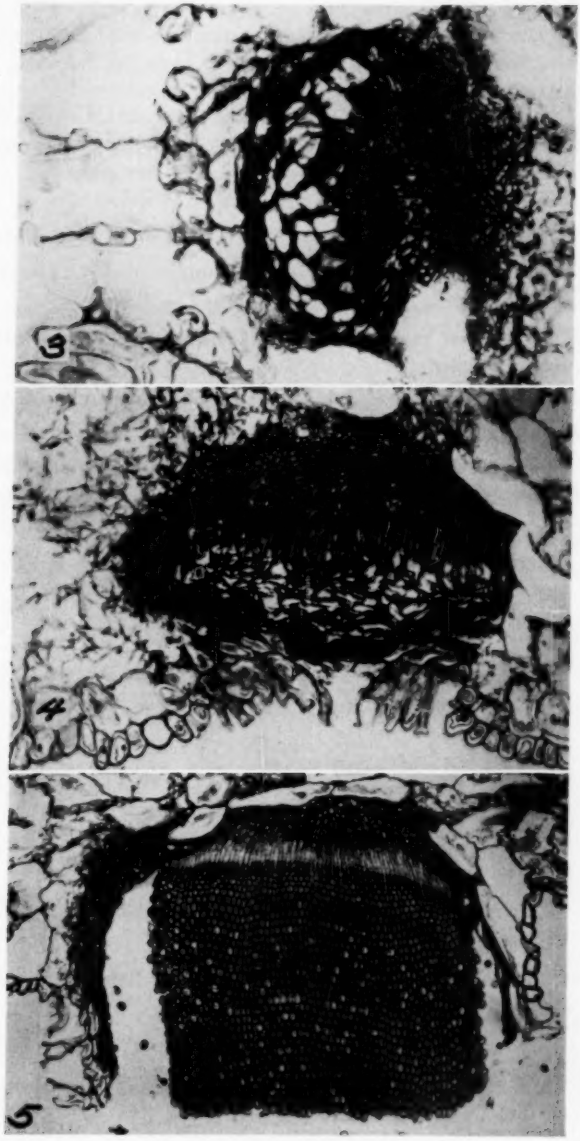


FIG. 3. Young aecium showing buffer cells, × 300. FIG. 4. Developing aecium showing crushing of buffer cells, × 155. FIG. 5. Mature, open aecium, × 107.

Hyphae superficial, spreading, fuliginous, hypophyllous; in spots becoming confluent over entire lower surface of leaf; anastomosing to form a reticulum; 3–5 μ in diameter, even to torulose, with numerous gnarled clumps of chlamydospores of variable size and shape. Conidiophores borne singly, simple, fuscous, 5–9 μ long, 1–2 celled. Conidia solitary, acrogenous, abruptly obclavate fuscous, distal portion attenuated and pallid, becoming dark with age, 5–13-septate, constricted at septa, 8.5–12 × 54–72 μ.

On *Torreya californica* Torr. North Canyon Creek, Eldorado Co., California, Sept. 7, 1949; near summit of Mt. Tamalpais, Marin Co., California, **type**, Oct. 1, 1949, Lee Bonar.

Infection rare or lacking on current season's leaves. Abundant on second- and third-year leaves.

Conidia germinate on agar by several germ tubes after 4–5 days at room temperature. Growth on corn meal agar very slow. Forms sterile colony of brown hyphae 1–2 centimeters in diameter in eight weeks at room temperature.

DEPARTMENT OF BOTANY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA

SOME NEW GRASS SMUT RECORDS FROM THE WESTERN STATES. II [1]

GEORGE W. FISCHER

(WITH 1 FIGURE)

Since the publication in 1938 of the first of this series of new grass smut records from western states,[2] there has gradually accumulated a considerable number of records that have not found their way into publication media elsewhere.

The following records are supported by specimens deposited in the herbarium of the Department of Plant Pathology, State College of Washington, or the Mycological Collections of the Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland, or both. The latter are indicated by "B.P.I. No."

ENTYLOMA IRREGULARE Johanns.

New host: *Deschampsia caespitosa* (L.) Beauv., Sage Creek Junction, Utah, Aug. 3, 1948, Coll. J. P. Meiners and R. Sprague, B.P.I. No. 85675.

New state record: Washington: Puyallup, on *Poa annua* L., June 8, 1948, Coll. R. Sprague, B.P.I. No. 85508.

SOROSPORIUM CONSANGUINEUM Ell. and Ev.

New host: On *Aristida purpurea* Nutt., Vernon, Ariz., June 12, 1947, Coll. R. Sprague, B.P.I. No. 85495.

New state record: Idaho: White Bird, on *Aristida longiseta* var. *robusta* Merr., June 28, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85325.

[1] Published as Scientific Paper No. 935, Washington Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington.

[2] Fischer, George W. Some new grass smut records from the Pacific Northwest. Mycologia **30**: 385–395. 1938.

SOROSPORIUM SYNTHERISMAE (Peck) Farl.

New state record: Idaho: Mesa, on *Panicum capillare* L., Aug. 20, 1941, Coll. G. W. Fischer and E. J. Kreizinger, B.P.I. No. 85045.

SPHACELOTHECA CRUENTA (Kühn) Potter

New state record: New Mexico: Hot Springs, on *Sorghum halepense* (L.) Pers., June 12, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85413. Garfield: June 13, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85420.

SPACELOTHECA MONTANIENSIS (Ellis and Holway) Clinton

New state record: Colorado: Leadville, on *Muhlenbergia cuspidata* (Torr.) Rydb., Aug. 7, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85614.

SPACELOTHECA SORGHI (Lk.) Clinton

New state record: Washington: Puyallup, on *Sorghum vulgare* var. *sudanense* (Piper) Hitchc., Aug., 1938, Coll. K. Baur, B.P.I. No. 85078.

TILLETIA ELYMI Diet. and Holw.

New state record: Idaho: Selway National Forest, on *Elymus glaucus* Buckl., Sept. 10, 1949, Coll. Verne Comstock, B.P.I. No. 85524.

TILLETIA GUYOTIANA Har.

New state record: Idaho: Troy, on *Bromus japonicus* Thunb., Aug. 22, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85674.

UROCYSTIS AGROPYRI (Preuss) Schroet.

New hosts: On *Agropyron inerme* (Scribn. and Sm.) Rydb., Othello, Wash., June 18, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85298; *Agropyron subsecundum* var. *andinum* (Scribn. and Sm.) Hitchc., Loveland Pass, Colo., Aug. 7, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85615; *Elymus*

macounii Vasey, Chimney Rock, Colo., Aug. 10, 1948, Coll. R. Sprague and J. P. Meiners, B.P.I. No. 85622; Ephrata, Wash., Aug. 14, 1947, Coll. J. D. Menzies, B.P.I. No. 85505; *Phleum alpinum* L., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85633; Skyway Point, Grand Mesa, Colo., Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85606; *Poa canbyi* (Scribn.) Piper, Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85634; *Poa nervosa* (Hook) Vasey, Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85643; *Poa secunda* Presl., Lewiston, Idaho, April 30, 1939, Coll. R. Daubenmire, B.P.I. No. 85132; Latah County, Ida., April 25, 1938, Coll. R. Daubenmire, B.P.I. No. 85165.

New state records: Colorado: Silver Plume, on *Bromus ciliatus* L., Aug. 7, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85617. Meeker: On *Agropyron smithii* Rydb., Aug. 5, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85600; Montana: Whitehall, on *Agropyron smithii* Rydb., Aug. 2, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85376; Utah: Clinton, on *Agropyron smithii* Rydb., June 8, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85448; Salt Lake City: July 16, 1940, Coll. G. W. Fischer, B.P.I. No. 85131; Oregon: Madras, on *Elymus triticoides* Buckl., July 13, 1948, Coll. G. W. Fischer and J. P. Meiners, B.P.I. No. 85515; Idaho: McCall, on *Koeleria cristata* (L.) Pers., Aug. 1, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85557; Washington: Pullman, on *Poa ampla* Merr., July 1, 1948, Coll. J. P. Meiners, B.P.I. No. 85535; Wyoming: Togwotee Pass, on *Agropyron trachycaulum* (Link) Malte, Aug. 12, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85655.

UROCYSTIS FRASERI Clinton and Zundel

New host: On *Stipa columbiana* Macoun, Mac's Inn, Ida., Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85663.

New state records: Idaho: Ririe, on *Stipa comata* Trin. and Rupr., July 27, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85361; North Dakota: Appam, on *Stipa comata* Trin. and Rupr., June 11, 1944, Coll. R. Sprague, B.P.I. No. 85453; Oregon: Baker (13 mi. east toward Richland), on *Stipa comata* Trin. and Rupr., June 29, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85323; Utah: Sheep Creek Canyon, Daggett County, on *Stipa comata* Trin. and Rupr., Aug. 4, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85605.

USTILAGO ACULEATA (Ule) Liro

New state records: Colorado: Cedaredge, on *Elymus glaucus* Buckl., Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85612; Idaho: Hagerman, on *Elymus canadensis* L., July 22, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85345; Montana: Belgrade, on *Elymus canadensis* L., July 30, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85369; Utah: Clinton, on *Elymus condensatus* Presl., June 7, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85489; Washington: Lenore Lake, on *Agropyron inerme* (Scribn.) (Smith) Rydb., June 19, 1945, Coll. G. W. Fischer and A. G. Law B.P.I. No. 85282. Washtucna: June 18, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85294. Pullman: On *Elymus canadensis* L., July 11, 1947, Soil Conservation Nurseries, Coll. J. P. Meiners and R. Sprague, B.P.I. No. 85481; Wyoming, Teton Pass, on *Elymus glaucus* Buckl., Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85658.

USTILAGO BULLATA Berk.

New host: On *Bromus macrostachys* Desf., Pullman, Wash., Bureau of Plant Industry Grass Nursery, June, 1938, Coll. G. W. Fischer, B.P.I. No. 85164.

New state records: Colorado: Grand Valley, on *Bromus japonicus* Thunb., Aug. 5, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85599. Broomfield: On *Bromus japonicus* Thunb., Aug. 8, 1948, Coll. G. W. Fischer, R. Sprague, and

J. P. Meiners, B.P.I. No. 85618. Loyd: On *Hordeum jubatum* var. *caespitosum* (Scribn.) Hitchc., Aug. 5, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85583; Idaho: Moscow, on *Agropyron dasystachyum* (Hook.) Scribn., July 23, 1943, Coll. G. W. Fischer, B.P.I. No. 85079. Lucille: On *Bromus brizaeformis* Fisch. and Mey., June 28, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85328. On *Bromus japonicus* Thunb., June 28, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85301. Culdesac: On *Bromus mollis* L., June 4, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85387. Lucille: On *Bromus rigidus* Roth., June 28, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85327. Preston: On *Hordeum jubatum* var. *caespitosum* Scribn. and Sm., Aug. 2, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85565; Montana: Bozeman, on *Agropyron dasystachyum* (Hook.) Scribn., July 30, 1945, Coll. G. W. Fischer, B.P.I. No. 85351. On *Elymus canadensis* L., July 30, 1945, Coll. G. W. Fischer, B.P.I. No. 85370. On *Elymus glaucus* Buckl., July 30, 1945, in Bureau of Plant Industry Grass Nursery, Coll. G. W. Fischer, B.P.I. No. 85350; Utah: Woodruff, on *Agropyron trachycaulum* (Link) Malte., Aug. 3, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85573. On *Elymus macounii* Vasey, Aug. 3, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85568; Washington: Ephrata, on *Elymus macounii* Vasey, Aug. 14, 1947, Coll. J. D. Menzies, B.P.I. No. 85506; also Chewelah: June 21, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85274; Wyoming: Medicine Bow National Forest, on *Bromus ciliatus* L., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85630. Teton Pass: On *Bromus purgans* L., Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85659. Almy: On *Elymus macounii* Vasey, Aug. 3, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85574.

USTILAGO CRUS-GALLI Tracy and Earle

New state record: Idaho: Twin Falls, on *Echinochloa crus-galli* L. (Beauv.), Aug. 10, 1936, Coll. W. H. Pierce, B.P.I. No. 85071.

USTILAGO HILARIAE Ell. and Tracy

New state records: Arizona: Vermillion Cliffs, on *Hilaria jamesii* (Torr.) Benth., June 10, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85497; Utah: Wellington, on *Hilaria jamesii* (Torr.) Benth., June 7, 1940, Coll. V. Vasileff, B.P.I. No. 85028.

USTILAGO LONGISSIMA (Schlecht.) Meyen

New host: On *Glyceria pauciflora* Presl., Ellensburg, Wash., July 3, 1937, Coll. G. W. Fischer, B.P.I. No. 85462.

USTILAGO HYPODYTES (Schlecht.) Fries

New state record: Oklahoma: Woodward, on *Stipa comata* Trin. and Rupr., Aug. 31, 1940, Coll. C. L. Lefebvre, B.P.I. No. 85043.

USTILAGO RESIDUA Clint.

New state record: Idaho: Ferdinand, on *Danthonia californica* Boland, June 27, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85334.

USTILAGO SITANII G. W. Fisch.

New hosts: On *Distichlis stricta* (Torr.) Rydb., Corfu, Wash., July, 1940, Coll. D. C. Smith and J. R. Swallen, B.P.I. No. 85067; June 18, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85293. At first it was thought that this brown stripe smut on salt grass (Fig. 1) represents a new species. However, it is morphologically indistinguishable from *Ustilago sitanii*, although this species has not heretofore been recognized as occurring on grasses outside of the tribe *Hordeae*. Because of its morphological similarity and symptomatic characters, the smut on *Distichlis* is assigned to this species; *Elymus salina* Jones, Massadona, Colo., Aug. 4, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85570; *Poa secunda* Presl., Baker, Ore., July 25, 1941, Coll. G. W. Fischer and J. R. Hardison, B.P.I. No. 85066. As in the case with the brown stripe smut on *Distichlis stricta* mentioned above, this smut was at first thought to be a new species. However, after subsequent study, it seems best to place it in *Ustilago*

FIG. 1. *Ustilago sitanii* on *Distichlis stricta*.

sitanii because of its morphological and symptomatic similarity to that species; *Poa pratensis* L., Silvies, Ore., June 25, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85449.

New state records: Oregon: Wasco County, on *Sitanion hystrix* (Nutt.) J. G. Smith, July 13, 1948, Coll. G. W. Fischer and J. P. Meiners, B.P.I. No. 85517.

USTILAGO SPEGAZZINII Hirschh.

New state record: Oregon: Redmond, on *Agropyron spicatum* (Pursh) Scribn. and Sm., July 13, 1948, Coll. G. W. Fischer and J. P. Meiners, B.P.I. No. 85511.

USTILAGO SPEGAZZINII var. AGRESTIS (Syd.) G. W. Fisch. and Hirschh.

New hosts: On *Agropyron caninum* (L.) Beauv., Pullman, Wash., Soil Conservation Nurseries, July 7, 1944, Coll. G. W. Fischer, B.P.I. No. 85353; *Agropyron dasystachyum* (Hook.) Scribn., Pullman, Wash., Soil Conservation Nurseries, July 7, 1944, Coll. G. W. Fischer, B.P.I. No. 85227; *Agropyron riparium* Scribn. and Sm., Madras, Ore., May 30, 1944 (on culms from preceding season), Coll. G. W. Fischer, B.P.I. No. 85217; *Agropyron sibericum* (Willd.) Beauv., Pullman, Wash., Soil Conservation Nurseries, July 10, 1944, Coll. G. W. Fischer, B.P.I. No. 85223; *Elymus glaucus* Buckl., Halsey, Ore., June 7, 1944, Coll. G. W. Fischer, B.P.I. No. 85220, Pullman, Wash., Soil Conservation Nurseries, July 7, 1944, Coll. G. W. Fischer, B.P.I. No. 85226; *Oryzopsis hymenoides* (Roem. and Schult.) Rick., Mt. Carmel, Utah, June 9, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85493.

New state records: Nevada: Ryepatch, on *Elymus condensatus* Presl., June 23, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85436. Quinn River Crossing: On *Sitanion hystrix* (Nutt.) J. G. Sm., June 23, 1947, Coll. R. Sprague and J. P. Meiners, B.P.I. No. 85494; Oregon: Madras, on *Agropyron spicatum* (Pursh) Scribn. and Sm., July 13, 1948, Coll. G. W. Fischer and J. P. Meiners, B.P.I. No. 85514. Denio: On *Elymus condensatus* Presl., June 24, 1947, Coll. G. W. Fischer, R. Sprague,

and J. P. Meiners, B.P.I. No. 85439; on *Elymus triticoides* Buckl., Union, Ore., June 29, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85308; Washington: Dayton, on *Sitanion jubatum* J. G. Sm., June 30, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85311.

USTILAGO STRIIFORMIS (West.) Niessl

New hosts: On *Agrostis humilis* Vasey, Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer and R. Sprague, B.P.I. No. 85639; *Agrostis rossae* Vasey, Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85642; *Agrostis scabra* Welld., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85637; *Bromus ciliatus* L., Skyway, Colo., Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85553; Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85632; *Calamagrostis scribneri* Beal., Mac's Inn, Ida., Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85664; *Deschampsia atropurpurea* (Wahl.) Scheele., Filmore, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85627; *Deschampsia caespitosa* (L.) Beauv., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85647; *Festuca idahoensis* Elmer, 11 miles west of Sisters, Ore., July 12, 1948, Coll. G. W. Fischer and J. P. Meiners, B.P.I. No. 85593; *Festuca ovina* var. *brachyphylla* (Schult.) Piper, Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85644; *Koeleria cristata* L. Pers., Skyway Point, Grand Mesa, Colo., Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85608; McCall, Ida., Aug. 1, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85557; Silvies, Ore., June 25, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85451; *Melica spectabilis* Scribn., Togwotee Pass, Shoshone National Forest, Wyo., Aug. 12, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85646; *Muhlenbergia montanensis* (Scribn.) Scribn., Chimney Rock, Colo., Aug. 10, 1948, Coll. G. W. Fischer,

R. Sprague, and J. P. Meiners, B.P.I. No. 85620; *Phleum alpinum* L., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85649; *Poe reflexa* Vasey and Scribn., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85640; *Puccinellia nuttalliana*, 9 mi. west of Union, Ore., June 29, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85315; *Trisetum spicatum* (L.) Richt., 8 mi. west of Centennial, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85635.

New record for North America: On *Poa alpina* L., Medicine Bow National Forest, Wyo., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85636 also No. 85650.

New state records: Colorado: 10 mi. north of Glendevey, on *Beckmania syzigachne* (Steud.) Fernald, Aug. 9, 1948, Coll. R. Sprague and J. P. Meiners, B.P.I. No. 85692. Sand Creek Pass: Aug. 9, 1948, Coll. R. Sprague and J. P. Meiners, B.P.I. No. 85691. Carp Lake, Delta County: On *Calamagrostis canadensis* (Michx.) Beauv., Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85598. Skyway: Aug. 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85597; Idaho: Gooding, on *Elymus macounii* Vasey, Aug. 2, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85562. Ferdinand: On *Sitanion hystrix* (Nutt.) J. G. Sm., June 27, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85313; also McCall, July 21, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85379; Utah: Snyderville, on *Agrostis alba* L., June 7, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85396. Hoytsville: June 7, 1947, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85394. Hyde Park: July 14, 1940, Coll. G. W. Fischer, B.P.I. No. 85111; Washington: Ephrata, on *Elymus macounii* Vasey, Aug. 14, 1947, Coll. J. D. Menzies, B.P.I. No. 85504; Wyoming: Summit of Teton Pass, on *Agropyron trachycaulum* (Link) Malte, Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85660. Medicine Bow National Forest: On *Poa juncifolia* Scribn., Aug. 11, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85629.

USTILAGO WILLIAMSII (Griff.) Lavrov

New hosts: On *Stipa columbiana* Macoun., 8 mi. south of McCall, Ida., July 21, 1945, Coll. G. W. Fischer and C. S. Holton, B.P.I. No. 85354. Mac's Inn, Ida., Aug. 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85622. Beaver Summit, Cache County, Utah, Aug. 3, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85566; *Stipa williamsii* Scribn., Boundry, Wash., June 28, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85271. Northport, Wash., June 20, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85269.

New state records: Colorado: Craig, on *Oryzopsis hymenoides* (Roem. and Schult.) Rick., Aug. 5, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85582. Skyway: On *Stipa lettermanii* Vasey, Aug 6, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85605; Oregon: 13 mi. east of Baker, on *Stipa thurberiana* Piper, June 29, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85321. Haines: June 10, 1944, Coll. G. W. Fischer, B.P.I. No. 85219. 10 mi. south of Burns, June 9, 1944, Coll. G. W. Fischer, B.P.I. No. 85249. Redmond: July 13, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85512; Utah: Laketown, on *Oryzopsis hymenoides* (Roem. and Schult.) Rick., Aug. 3, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85569; Daggett County: Aug. 4, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85602. Daggett County: On *Stipa comata* Trin. and Rupr., Aug. 4, 1948, Coll. G. W. Fischer, R. Sprague, and J. P. Meiners, B.P.I. No. 85591; Washington: Quincy, on *Oryzopsis hymenoides* (Roem. and Schult.) Rick., June 19, 1945, Coll. G. W. Fischer and A. G. Law, B.P.I. No. 85288.

STATE COLLEGE OF WASHINGTON,
PULLMAN, WASHINGTON

UREDINALES OF CONTINENTAL CHINA COLLECTED BY S. Y. CHEO. II [1]

GEORGE B. CUMMINS

(WITH 11 FIGURES)

UROMYCES GERANII Fries. On *Geranium* sp.: ANHWEI: Ch'ing Yang Hsien, Sept. 1932, (*1130*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*1019*).

*UROMYCES CRASSIVERTEX Diet. On *Lychnis* sp.: KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*1012*).

The species has not been recorded from China and, since the urediospores have two equatorial pores, Cheo's specimen may not be this rust. Other characteristics agree closely with published descriptions of *U. crassivertex*.

*UROMYCES LEPTALEUS Syd. (FIG. 1). On *Stellaria* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1305*).

When Sydow (Annal. Mycol. **29**: 146. 1931) named the species, only uredia were described and I have found no subsequent description of the telia. The telial stage, present in Cheo's collection, is as follows:

Telia hypophyllous, scattered, subepidermal but soon ruptured, pulvinate, round, 0.1–0.3 mm. diam., blackish brown; teliospores (FIG. 1) ellipsoid or obovate, rounded or truncate above, narrowed below, 14–20 × 26–38 μ; wall 1.5–2 μ at sides, 9–14 μ at apex, smooth, golden-brown or clear chestnut-brown; pedicel about one-half length of spore, hyaline.

*UROMYCES HYPERICI Curt. On *Hypericum* sp.: KWANGSI: Ling Yuin Hsien, June 1933, (*2287*).

[1] Cooperative investigations between the Purdue University Agricultural Experiment Station and the Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Journal Paper Number 457, of the Purdue University Agricultural Experiment Station. Contribution from the Department of Botany and Plant Pathology.

UROMYCES AMURENSIS Kom. On *Millettia reticulata* Benth.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2842*).

U. amurensis has been reported only on *Maackia amurensis*. It is not possible with the present material to check the identity of the host.

UROMYCES LESPEDEZAE-PROCUMBENTIS (Schw.) Curt. On *Lespedeza* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1119, 1144, 1152, 1193*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*908, 916, 927, 930, 956*); KWANGSI: San Kiang Hsien, Sept. 1933, (*2724*), Yung Hsien, Oct. 1933, (*2892*); KWEICHOW: Tsunyi Hsien, July 1931, (*21*), Sze Nan Hsien, Aug. 1931, (*353*), Chiang K'ou Hsien, Sept., Oct. 1931, (*598, 804*).

*UROMYCES SOPHORAE-JAPONICAE Diet. On *Sophora* sp.: ANHWEI: Oct. 1932, (*1414*).

*UROMYCES SPHAEROCARPUS Syd. On *Indigofera* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1195*).

UROMYCES STRIATUS Schroet. On *Medicago lupulina* L.: KWEICHOW: July 1931, (*181*).

UROMYCES VIGNAE Barcl. On *Vigna sinensis* (L.) Endl.: KIANGSI: Sin Tsz Hsien, Sept. 1932 (*1073*); KWEICHOW: Tsunyi Hsien, July 1931, (*107*), Ching K'ou Hsien, Sept. 1931, (*572, 582*), Sze Nan Hsien, Sept. 1931, (*334*). On *Vigna vexillata* Benth.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1197*). On *Vigna* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1146*).

UROMYCES FABAE (Pers.) De B. On *Vicia unijuga* A. Br.: KIANGSI: Sin Tsz Hsien, Sept. 1932, (*1045*). On *Vicia* sp.: KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1713*).

UROMYCES PHASEOLI (Pers.) Wint. On *Phaseolus angularis* Wight: KWANGSI: Yung Hsien, Oct. 1933, (*2907*). On *Phaseolus chrysantha* Savi: KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*962*). On *Phaseolus vulgaris* L.: KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*464, 495*). On *Phaseolus* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1235*); KWANGSI: Yung Hsien, Oct. 1933, (*2909*). On *Vicia* sp.: KWEICHOW: Tsunyi Hsien, July 1931, (*125*).

UROMYCES COMMELINAE Cooke. On *Commelina* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1106*); KIANGSI: Sin Tsz Hsien,

Sept. 1932, (*894*). On *Pollia* sp.: KWANGSI: Yung Hsien, Aug. 1933, (*2367*).

UROMYCES ALOPECURI Seym. On *Alopecurus* sp.: Ling Yuin Hsien, Mar., Apr. 1933, (*1734, 1883*).

UROMYCES CORONATUS Miyabe & Nishida. On *Zizania* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1391*); KWANGSI: Yung Hsien, Oct. 1933, (*2914*); KWEICHOW: Sze Nan Hsien, Aug. 1931, (*329*).

*UROMYCES LEPTODERMUS Syd. On *Setaria* sp.: Ch'ing Yang Hsien, Oct. 1932, (*1104*); KWANGSI: Yung Hsien, Aug. 1933, (*2458*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*571*).

***Uromyces kwangsianus** sp. nov. (FIG. 2). Spermogoniis et aeciis ignotis. Urediis hypophyllis (abaxialibus), subepidermalibus, ellipsoideis vel linearibus, 0.3–0.5 mm. longis, cinnamoneo-brunneis; urediosporis late ellipsoideis, ellipsoideis, vel obovatis, 16–23 × 22–27 μ; membrana 2 μ crassa, echinulata, pallide cinnamomeo- vel aureo-brunnea; poris germ. 2, superequatorialibus. Teliis urediis conformibus sed atro-brunneis; teliosporis (FIG. 2) obovatis vel clavatis, ad apicem rotundatis vel truncatis, deorsum attenuatis, 14–19 × (24–)26–35 μ; membrana 2–2.5 μ crassa, ad apicem 5–8 μ, castaneo- vel aureo-brunnea, levi; pedicello plus minusve sporam aequante, aureo, persistenti.

On *Fimbristylis* sp.: KWANGSI: Ta Tseh Tsuen, Yung Hsien, Oct. 14, 1933, *S. Y. Cheo 2888* (type!).

Both the uredia and the telia originate just beneath the epidermis and open by a rather narrow slit in the epidermis. The teliospores arise from a thick, brown, stromatic hymenial complex which also produces, peripherally, a limited amount of thick-walled tissue somewhat like the stromatic paraphyses in loculate telia. As the sorus matures this "buffer" tissue becomes dark brown and crushed.

No species of *Uromyces* has been published with which this rust can be identified. This statement is based upon a survey of files in my possession and Guyot's (Encycl. Mycol. **8**: 199–232. 1938) synopsis of the species of *Uromyces* known to occur on the Cyperaceae. *U. kwangsianus* may possibly be closely related to *Puccinia fimbristylidis* Arth., a species with two superequatorial pores and generally similar spores. Subepidermal paraphyses are much more abundant in the latter species, however. Since the aecial stage is not known for either, this possible relationship can only be suggested.

PUCCINIA WATTIANA Barcl. On *Clematis* sp.: KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1826*).

In habit this collection differs from other available material of *P. wattiana* in that the sori occur in concentric rings about 1 mm. apart and around a centrally located group of epiphyllous, subepidermal, globoid spermogonia. Sydow and Mitter (Annal. Mycol. **33**: 51. 1935) have described a concentric arrangement of sori in an Indian collection on *C. buchananianae*. More recently Tai (Farlowia **3**: 124. 1947) has described a new species *P. clematidicola* on *C. connata* from China. This rust also has epiphyllous and circinately arranged telia. Tai did not describe spermogonia nor have they been reported as occurring in *P. wattiana* but they occur very sparingly on a cultivated *Clematis* collected by Stewart (No. 14673) at Dehra Dun, India.

In all specimens examined, including some labelled as *P. exhausta* Diet., the teliospores are quite characteristic in that the pore of the lower cell is near the pedicel and both pores are covered with an hemispheric papilla. Tai has described and illustrated the same characteristic for *P. clematidicola*. He also records the occurrence of *P. wattiana* on *C. peterae* but without commenting on the general similarity of the rusts. Sawada (Jour. Taihoku Soc. Agr. & For. **7**: 32. 1943) has described what appears to be a microcyclic species, *P. clematidis-hayatae*, in Formosa. The teliospores are described as only 8–13 μ wide. Apparently the species is distinct and is so recorded by Hiratsuka (Mem. Tottori Agric. College **7**: 45. 1943).

*PUCCINIA FUSISPORA Syd. On *Boehmeria* sp.: KWEICHOW: Chiang K'ou Hsien, Nov. 1931, (*844*).

P. fusispora parasitizes *Urtica angustifolia* while the host of Cheo's collection presumably is *Boehmeria*. The teliospores measure 11–14 × 43–54(–62) μ as against 8–11 × 40–55 μ for *P. fusispora*. This is the first record of a microcyclic *Puccinia* on either host in China.

Puccinia stellariicola nom. nov. (*Puccinia stellariae* Liou & Wang, Contrib. Inst. Bot. Natl. Acad. Peiping **2**: 162. 1934, not *Puccinia stellariae* Duby, Bot. Gall. **2**: 887. 1830). On *Stellaria* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2019*).

This microcyclic species, published by Liou and Wang under a preempted epithet, appears to be distinct. The teliospore wall is nearly hyaline, 1 μ thick at the sides and thickened to not more than 4 μ apically. Germination occurs without a rest period. The two cells separate easily, as originally described.

*PUCCINIA BENOKIYAMENSIS Hirats. f. On *Polygonum caespitosum* Blume: KWEICHOW: Tsunyi Hsien, July, Aug. 1931, (*100, 218*), Sze Nan Hsien, (*348*). On *Polygonum chinense* L.: KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*578*). On *Polygonum nepalense* Meisner: KWEICHOW: Tsunyi Hsien, July 1931, (*96*). On *Polygonum* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1108*); KWANGSI: Ling Yuin Hsien, Mar., May 1933, (*1731, 2068, 2069, 2100*), San Kiang Hsien, Sept., Oct. 1933, (*2732, 2762, 2774, 2779, 2825, 2923*); KWEICHOW: Chiang K'ou Hsien, Sept., Oct., Nov. 1931, (*357, 448, 657, 839*), Tsunyi Hsien, Aug. 1931, (*197*), Tungjen Hsien, Nov. 1931, (*814*).

This rust is characterized by urediospores having two pores adjacent to the hilum and clear chestnut-brown teliospores with the apical thickening paler in color. I have had type material of *P. benokiyamensis* for comparison.

PUCCINIA CONGESTA Berk. & Br. On *Polygonum* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1322*); KWANGSI: San Kiang Hsien, Sept. 1933, (*2823*).

PUCCINIA POLYGONI-AMPHIBII Pers. On *Polygonum* sp.: ANHWEI: Ch'ing Yang Hsien, Oct., Nov. 1932, (*1118, 1351, 1498*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*897*); KWANGSI: Ling Yuin Hsien, Mar., May 1933, (*1642, 2096*), Yung Hsien, Aug. 1933, (*2345*); KWEICHOW: Tsunyi Hsien, Aug. 1931, (*279, 321*), Sze Nan Hsien, Aug. 1931, (*331*). On *Polygonum* (*Tovara*) sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1228*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*529*).

The Chinese collections differ from American material in that the telia are early exposed and the urediospores mostly have equatorial pores. The aecial stage on *Geranium* has not been reported for China.

PUCCINIA POLYGONI-WEYRICHII Miyake. On *Polygonum* sp.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*782*).

I am not certain that this specimen is correctly placed, since I have had no material for comparison. Following Tranzschel (Conspectus Uredinalium URSS. 1939) the rust keys directly to *P. polygoni-weyrichii*. However, Tai (Farlowia **3**: 124. 1947) states that *P. polygoni-lapathifolii* Liou & Wang is probably synonymous with *P. polygoni-weyrichii*. The type material of Liou and Wang's species differs from Cheo's collection in having considerably more rotund teliospores with a smaller papilla over the apical germ pore. However, the urediospores of both have two pores adjacent to the hilum.

***Puccinia kweichowana** sp. nov. (FIG. 3). Spermogoniis et aeciis ignotis. Urediosporis teliis immixtis, late ellipsoideis vel plus minusve globoideis, 19–21 × 23–27 μ; membrana 2.5–3 μ crassa, valde echinulata, palide aurea vel flavida vel fere hyalina; poris germ. obscuris, verissimiliter 2, aequatorialibus. Teliis epiphyllis, subepidermalibus, sparsis, rotundatis, 0.4–0.8 mm. diam., maculis purpureis 2 mm. diam. insidentibus, cinnamomeo-brunneis, pulverulentis; teliosporis (FIG. 3) plerumque ellipsoideis, 21–25 × 30–40(–42) μ, utrinque rotundatis, medio non vel vix constrictis; membrana cinnamomeo-brunnea, 1.5–2 μ crassa, supra poros usque ad 4 μ in papillam hyalinam incrassata, levi; poro superiore apicali, inferiore juxta septum sito; pedicello fragili, hyalino, brevi.

On *Polygonum campanulatum* Hook. f. var. *likiangensis* (W. W. Sm.) Steward: KWEICHOW: Fan Ching Shan, Chiang K'ou Hsien, Oct. 3, 1931, *S. Y. Cheo 651* (type!).

P. kweichowana has the general appearance of *P. mammillata* Schroet. but differs mainly in that the lower germ pore of the teliospore is next to the septum rather than near the pedicel. In addition the sori are epiphyllous and the urediospores strongly echinulate. *Puccinia septentrionatis* Juel and *P. parca* Arth. have teliospores with both pores apically placed but the spores of *P. kweichowana* are significantly broader. The hyaline papilla over each germ pore is much more conspicuous than in *P. sibirica* Tranz., the teliospores are broader, and the urediospores have thicker walls.

PUCCINIA ACETOSAE (Schum.) Koern. On *Rumex* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1366*).

***Puccinia corylopsidis** sp. nov. (FIG. 4). Spermogoniis, aeciis, et urediis ignotis. Teliis hypophyllis, sparsis, rotundatis, 0.1–0.8 mm. diam., pulvinatis, cinnamomeo- vel castaneo-brunneis; teliosporis (FIG. 4) ellipsoideis vel fusiformiter ellipsoideis (18–)22–27(–29) × 60–73 μ, ad septum non constrictis;

FIG. 1. Teliospores of *Uromyces leptaleus* Syd. on *Stellaria (Cheo 1305)*; FIG. 2. Teliospores of *Uromyces kwangsianus* Cumm. on *Fimbristylis* (type); FIG. 3. *Puccinia kweichowana* Cumm. on *Polygonum* (type); FIG. 4. *Puccinia corylopsidis* Cumm. on *Corylopsis* (type); FIG. 5. *Puccinia kwangsiana* Cumm. on *Saussurea* (type); FIG. 6. *Puccinia sinicensis* Cumm. on undet. Orchidaceae (type). × 800.

membrana minute verrucosa, bilaminata, aureo- vel cinnamomeo-brunnea, unilateraliter incrassata, partim tenui 2 μ, partim incrassata usque ad 10 μ, ad apicem 12–29 μ, poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello semipersistenti, hyalino, 3–5 μ lata, usque ad 150 μ longo.

On *Corylopsis* sp.: KWANGSI: Lao Shan, Ling Yuin Hsien, Apr. 30, 1933, *S. Y. Cheo 1993* (type!).

This parasite stimulates the host to produce small, globoid galls 200–300 μ in diameter and rising about the same distance above the normal surface of the leaf. The telia are initiated subepidermally in the apical region of the galls. In most spores the wall is unilaterally thickened and obviously bilaminate, with the outer golden-brown portion accounting for most of the thickness.

Aecidium hamamelidis Diet. has been collected on *Corylopsis* but I have found no record of a species of *Puccinia*.

*PUCCINIA ELAEAGNI Yosh. On *Elaeagnus lanceolata* Warb. subsp. *grandifolia* Serv.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*684*).

PUCCINIA VIOLAE (Schum.) DC. On *Viola* spp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1218*); KWANGSI: Sept. 1933, (*2782*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*447, 511*).

No. 447 represents a mixture of *P. violae* and *Uredo iyoensis* Hirats. f. & Yosh.

PUCCINIA DIETELIANA Syd. On *Lysimachia clethroides* Duby: KWEICHOW: Tsunyi Hsien, July 1931, (*14*). On *Lysimachia paradiformis* Franch: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*682*). On *Lysimachia* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1313*).

PUCCINIA CONVOLVULI (Pers.) Cast. On *Calystegia* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1278*); KWEICHOW: Tsunyi Hsien, July 1931, (*122*). Sze Nan Hsien, Aug. 1931, (*343*).

PUCCINIA GLECHOMATIS DC. On *Glechoma* sp.: KWANGSI: Ling Yuin Hsien, June 1933, (*2215*).

PUCCINIA MENTHAE Pers. On *Lycopus europaeus* L.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1540*). On *Origanum vulgare* Lam.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1348*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*1021*). On *Origanum* sp.: KWANGSI: Ling Yuin Hsien, June 1933, (*2212*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*373*).

PUCCINIA NANBUANA P. Henn. On *Peucedanum decursivum* (Miq.) Maxim.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1158*). On *Peucedanum* sp.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2736, 2812*).

PUCCINIA OENANTHES Miyake. On *Oenanthe* sp.: KWANGSI: Ling Yuin Hsien, Mar., Apr. 1933, (*1626, 1886*).

*PUCCINIA SANICULAE Grev. On *Sanicula europaea* L.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*654*).

PUCCINIA TOKYENSIS Syd. On *Cryptotaenia* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2166*), Yung Hsien, Aug. 1933, (*2407*).

PUCCINIA PATRINIAE P. Henn. On *Patrinia* sp.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2805*).

*PUCCINIA TENUIS Burrill. On *Eupatorium* sp.: KWANGSI: Ling Yuin Hsien, June 1933, (*2214*).

P. tenuis has been recorded previously from China but later Teng and Ou (Sinensia **8**: 264. 1937) reported that the host was *Aster trinervis* and the rust *Puccinia caricis-asteris*. The host of Cheo's collection is sterile but has the appearance of *Eupatorium*. Only the aecial stage of the rust is present but it agrees well with that of *P. tenuis*.

PUCCINIA HELIANTHI Schw. On *Helianthus tuberosus* L.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1223*).

***Puccinia kwangsiana** sp. nov. (FIG. 5). Spermagoniis et aeciis ignotis. Urediis hypophyllis, subepidermalibus, sparsis vel laxe aggregatis, cinnamomeis, rotundatis, 0.1–0.4 mm. diam.; urediosporis late ellipsoideis vel plus minusve globoideis, 16–21 × 19–25 μ; membrana cinnamomeo-brunnea, moderate echinulata, 1–1.5 μ crassa; poris germ. 2, aequatorialibus. Teliis similibus sed atro-brunneis, pulverulentis; teliosporis (FIG. 5) variabilibus sed praecipue ellipsoideis, utrinque rotundatis, medio non vel vix constrictis, 18–24 × 27–38 μ; membrana uniformiter 2–2.5 μ crassa vel minute umbonata, castaneo-brunnea, minute punctato-verrucosa; poris germ. superioribus plerumque apicalis, inferioribus plerumque juxta septum dispositis; pedicello hyalino, fragili, caduco, frequenter oblique inserto.

On *Saussurea* sp.: KWANGSI: Ling Wang Shan, San Kiang Hsien, Sept. 15, 1933, *S. Y. Cheo 2742* (type!).

This species has much smaller urediospores and smaller, thinner-walled teliospores than *P. saussureae*. The teliospores are smaller and darker than those of *P. saussureae-usuriensis* Liou & Wang.

P. saussureae-alpinae Lior differs in having larger urediospores with three pores and the lower pore of the teliospore usually located midway in the cell. Most of the teliospores are ellipsoid but considerable variability exists with some spores angular and a few diorchidioid.

PUCCINIA CHRYSANTHEMI Roze. On *Chrysanthemum* sp.: ANHWEI: Ch'ing Yang Hsien, Oct., Nov. 1932, (*1329, 1486*); KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*652*).

PUCCINIA MILLEFOLII Fckl. *sensu lat.* On *Artemisia* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2040*); KWEICHOW: Tsunyi Hsien, July, Aug. 1931, (*64, 265*).

*PUCCINIA ADJUNCTA Mitter. On *Artemisia* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1147, 1276*).

This species has been reported only from India but Cheo's collections agree well, with teliospores 18–24 × 48–63 μ and the apical wall only 4–7 μ in thickness.

PUCCINIA ABSINTHII DC. On *Artemisia* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1225, 1253, 1263, 1285, 1304*); KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1957*), Yung Hsien, Oct. 1933, (*2915*); KWEICHOW: Tsunyi Hsien, July 1931, (*53, 139*), Chiang K'ou Hsien, Oct. 1931, (*683*).

PUCCINIA OBTEGENS (Link) Tul. On *Cirsium arvense* (L.) Scop.: KWEICHOW: Tsunyi Hsien, July 1921, (*40*).

*PUCCINIA CIRSII-MARITIMI Diet. On *Cirsium chinense* Champ.: KIANGSI: Sin Tsz Hsien, Sept. 1932, (*1054*). On *Cirsium* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1188*).

*PUCCINIA BARDANAE (Wallr.) Cda. On *Arctium majus* Bernh.: KIANGSI: Sin Tsz Hsien, Sept. 1932, (*1049*).

PUCCINIA HIERACII (Schum.) Mart. On *Taraxacum officinale* Weber: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1590*).

PUCCINIA MINUSSENSIS Thuem. On *Lactuca* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1129, 1172*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*895, 1016, 1017*); KWANGSI: San Kiang Hsien, Sept. 1933, (*2731*); KWEICHOW: Tsunyi Hsien, July, Aug. 1931, (*119, 227*).

*PUCCINIA ASPARAGI-LUCIDI Diet. On *Asparagus* sp.: KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1879*), Yung Hsien, Aug. 1933, (*2654*).

*PUCCINIA SMILACINAE Syd. On *Polygonatum* sp.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*625*).

The species was described from Formosa on *Smilacina japonica* but has not been reported for continental China.

*PUCCINIA DISPORI Syd. On *Disporum* sp.: KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1945*).

Puccinia dispori has, so far as I am aware, been collected only in the Philippine Islands. It is not greatly different from *P. smilacinae*.

PUCCINIA FUNKIAE Diet. On *Hosta coerulea* (Andr.) Tratt.: KWEICHOW: Nov. 1931, (*805*).

PUCCINIA IRIDIS (DC.) Wallr. On *Iris* sp.: KWANGSI: Ling Yuin Hsien, June 1933, (*2196*), San Kiang Hsien, Sept. 1933, (*2738*).

*PUCCINIA NASUENSIS Hirats. f. On undetermined Orchidaceae: KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*1033*); KWANGSI: San Kiang Hsien, Sept. 1933, (*2729*).

P. nasuensis is known only from Japan on *Calanthe reflexa*. Hiratsuka did not give the number or location of the pores in the urediospores. In the Chinese material they are two and equatorial. The teliospores agree well as to size and thickness of the apical wall.

***Puccinia sinicensis** sp. nov. (FIG. 6). Spermogoniis et aeciis ignotis. Urediosporis teliis immixtis, obovatis vel late ellipsoideis, 19–23 × 26–30 μ; membrana hyalina vel pallide flavidula, minute echinulata, 2 μ crassa; poris germ. obscuris. Teliis hypophyllis, subepidermalibus, sparsis vel laxe aggregatis, atro-brunneis, pulvinatis, rotundatis, usque ad 1.0 mm. diam.; teliosporis (FIG. 6) clavatis vel ellipsoideo-clavatis, ad apicem rotundatis, deorsum rotundatis vel plerumque attenuatis, medio vix vel leniter constrictis, 17–23 × 36–56 μ; membrana castaneo-brunnea, 1.5–2.5 μ crassa, ad apicem 6–10 μ crassa, levi; poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello persistenti, pallide flavido, plus minusve sporam aequante.

On undetermined Orchidaceae: KWANGSI: Ling Wang Shan, San Kiang Hsien, Sept. 19, 1933, *S. Y. Cheo 2814* (type!).

This species has teliospores of the same general type as those of *P. nasuensis* but they are shorter while the urediospores are essentially colorless and have short echinulations.

***Puccinia anhweiana** sp. nov. (FIG. 7). Spermogoniis et aeciis ignotis. Urediis ordinariis incertis; urediosporae late ellipsoideae, 17–19 × 20–23 μ; membrana 1.5 μ crassa, moderate echinulata, pallide brunnea; poris germ. 3, aequatorialibus. Amphisoris amphigenis vel praecipue epiphyllis, sparsis, sub-

epidermalibus et tarde nudis, castaneo-brunneis, rotundatis, 0.1–0.5 mm. diam. vel variabilibus et usque ad 1.0 mm. longis; amphisporis (FIG. 7) obovoideis vel plus minusve pyriformibus, 15–20 × 25–36 μ; membrana obscure cinnamomeo- vel pallide castaneo-brunnea, 2 μ crasso vel ad apicem 2.5 μ crassa, verrucoso-echinulata; poris germ. 3, aequatorialibus. Teliosporis amphisoris immixtis oblongis, utrinque truncatis vel basim versus attenuatis, medio non constrictis, 10–13 × 25–46(–56) μ; membrana hyalina vel pallide flavidula, 1 μ crassa, ad apicem 2–5 μ crassa, levi; poris germ. non visis; pedicello hyalino, brevissimo.

On *Orchis* (or undet. Orchidaceae): ANHWEI: Chiu Hua Shan, Ch'ing Yang Hsien, Oct. 15, 1932, *S. Y. Cheo 1267* (type!).

This is the first amphisporic species reported on Orchidaceae. The amphisori remain long covered by the epidermis and appear like telia, but eventually the epidermis breaks away as a cap and usually the entire sorus falls away leaving only a scar on the leaf. Presumably the teliospores are not resting spores although none was seen germinating nor were separate telia found. The colorless teliospores appear quite delicate.

*PUCCINIA SCIRPI-TERNATANI Hirats. f. On *Scirpus* sp.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*749*).

P. scirpi-ternatani was named without uredia and based on mostly germinated telia collected on Okinawa Island. The telia are subepidermal, or probably two or three cells deeper, with a surrounding hyphal complex. Cheo's collection has similar telia and teliospores as well as brown uredia formed in a linear series like the telia. The urediospores are thick-walled (3–4 μ), light chestnut-brown, echinulate, and have two equatorial pores. The spores are obovoid to ellipsoid, measure 19–26 × 29–40 μ, have semipersistant pedicels, and are probably amphisporic in nature.

The host of Cheo's specimen was originally labelled as *Carex*, and, while not specifically identical with *S. ternatanus*, is probably a species of *Scirpus*.

PUCCINIA CYPERI Arth. On *Cyperus* sp.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1516*); KWANGSI: Yung Hsien, Aug. 1933, (*2445*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*462*), Tsunyi Hsien, July 1931, (*176*).

PUCCINIA ROMAGNOLIANA Maire & Sacc. On *Cyperus difformis* L.: ANHWEI: Ch'ing Yang Hsien, Oct., Nov. 1932, (*1149, 1485*).

PUCCINIA LIBERTA Kern. On *Bulbostylis* sp.: KWANGSI: Lo

Ch'en Hsien, Oct. 1933, (*2877, 2880*); KWEICHOW: Tsunyi Hsien, July 1931, *Cheo 174*.

*PUCCINIA FIMBRISTYLIDIS Arth. On *Fimbristylis* sp.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2787*), Yung Hsien, Aug., Sept. 1933, (*2447, 2868*).

*PUCCINIA SCLERIAE-DREGEANAE Doidge. On SCLERIA sp.: KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1743*).

There is a small group of similar rusts on *Scleria*, the Chinese collection not agreeing precisely with any of them. It lacks the subepidermal stromatic paraphyses of *P. scleriae* (Paz.) Arth. and has only an occasional three-celled teliospore. The teliospores range from 31 to 66 μ in length, although most of them fall within the range of 30–45 μ described by Doidge for *P. scleriae-dregeanae*. *P. mirandensis* Kern & Thurst. has larger urediospores and teliospores.

PUCCINIA CARICIS-GIBBAE Diet. On *Carex* sp.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1591*); KWANGSI: Ling Yuin Hsien, May, June 1933, (*2091, 2295*); KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*645*), Tsunyi Hsien, Aug. 1931, (*283*).

*PUCCINIA SUBHYALINA Tranz. On *Carex* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1192*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*950*).

PUCCINIA LONGICORNIS Pat. & Har. On *Phyllostachys* sp.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1584*).

There is some question as to the identity of this collection since the teliospores are minutely rugose.

*PUCCINIA MELANOCEPHALA Syd. On *Phyllostachys puberula* Munro: KWEICHOW: Chiang K'ou Hsien, Sept., Nov. 1931, (*434, 806*); *Phyllostachys* sp.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1439*).

Only two immature teliospores were found in this material. They, as well as the urediospores and paraphyses, indicate that the rust is *P. melanocephala*, a species not previously recorded for China.

PUCCINIA POAE-SUDETICAE (Westend.) Jørst. On *Poa* sp.: KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1836*).

PUCCINIA MAGNUSIANA Koern. On *Phragmites communis* Trin.: ANHWEI: Nan Ling Hsien, Oct. 1932, (*1103*).

PUCCINIA MORIOKAENSIS S. Ito. On *Phragmites* sp.: ANHWEI: Nan Ling Hsien, Oct. 1932, (*1312*).

***Puccinia longinqua** sp. nov. (FIG. 8). Spermogoniis et aeciis ignotis. Urediis amphigenis, subepidermalibus, pulverulentis, cinnamomeo-brunneis, ellipsoideis vel oblongis et usque ad 1.0 mm. longis, eparaphysatis; urediosporis plerumque ellipsoideis, 13–17 × (19–)21–26 μ; membrana 2–2.5 μ, ad apicem rarius usque ad 3.5 μ, moderate echinulata, cinnamomeo-brunnea; poris germ. 3 vel 4, aequatorialibus. Teliis amphigenis et in vaginis culmisque evolutis, rotundatis vel oblongis, 0.4–2.0 mm., aggregatis et plus minusve confluentibus, atro-brunneis, pulvinatis, teliosporis (FIG. 8) ellipsoideis, utrinque rotundatis, medio moderate constrictis, 16–19 × (33–)40–54 μ; membrana 2.5–3 μ crassa, ad apicem 4–6 μ crassa, castaneo-brunnea, levi; poro superiore apicali, inferiore juxta septum sito, supra poros lenissime in umbonem pallidiorem incrassata; pedicello crasso-tunicato, pallide brunneolo vel fere hyalino, persistenti, usque ad 125 μ longo.

On *Phragmites* sp.: KWANGSI: Ta Tseh Shan, Yung Hsien, Aug. 6, 9, 1933, *S. Y. Cheo 2365, 2413* (type!).

This species has a combination of characters unlike any of the thirteen species previously recognized on the genus *Phragmites*. The urediospores are shorter than those of any other species having echinulate spores. The teliospores are similar to those of *P. tepperi* Ludw. but that species has verrucose urediospores. Urediospores are not described for *P. trabutii* Roum. & Sacc., *P. torosa* Thuem., *P. moriokaensis* S. Ito, *P. okatamaensis* S. Ito, and *P. abei* Hirats. but all have longer teliospores and, with the exception of *P. abei*, a thicker apical wall. *P. abei* has teliospores 20–30 μ wide and a uniform wall thickness.

PUCCINIA ARUNDINELLAE-ANOMALAE Diet. On *Arundinella anomala* Steud.: KIANGSI: Lu Shan, Sept. 1932, (*903*).

***Puccinia morigera** sp. nov. (FIG. 9). Spermogoniis et urediis ignotis. Urediis hypophyllis, subepidermalibus, sparsis, aureo- vel cinnamomeo-brunneis, ellipsoideis vel oblongis, 0.3–1.0 mm. longis, plus minusve pulvinatis, eparaphysatis; urediosporis globoideis vel late ellipsoideis, 18–23 × 19–26 μ; membrana 2–3 μ crassa, aureo- vel pallide cinnamomeo-brunnea, minute verrucosa; poris germ. 6 vel 7, sparsis. Teliis urediis similibus sed atro-brunneis, pulvinatis; teliosporis (FIG. 9) plerumque ellipsoideis, rarius clavato-ellipsoideis, utrinque rotundatis vel deorsum lenissime attenuatis, medio non vel vix constrictis, (19–)21–24(–26) × 30–46(–52) μ; membrana 2–3.5 μ crassa, ad apicem 6–9 μ crassa, castaneo-brunnea, levi; poro superiore apicali, inferiore juxta septum posito; pedicello pallide brunneolo, crasso-tunicato, persistenti, usque ad 90 μ longo.

On *Eragrostis* sp.: KWEICHOW: Fan Ching Shan, Chiang K'ou Hsien, Sept. 6, 1931, *S. Y. Cheo 385* (type!).

I have record of seven species of *Puccinia* on *Eragrostis: P. eragrostidicola* Kern, Thurst. & Whet and *P. cynosuroides* Syd., with paraphyses and verrucose urediospores; *P. eragrostidis-arundinaceae* Tranz. & Eremeeva, with verrucose urediospores but no paraphyses; *P. eragrostidis-superbae* Doidge, with paraphyses and echinulate spores; *P. eragrostidis* Petch and *P. eragrostidis-ferrugineae* Tai with echinulate spores but no paraphyses; and *P. eragrostidis-chalcanthae* Doidge, with uredia not described. *P. eragrostidis-arundinaceae* has larger urediospores (24–35 μ diam.) and only 2 or 3 pores. *P. eragrostidis-chalcanthae* has considerably smaller teliospores, measuring 17–25 × 26–28 μ. The other species are more obviously dissimilar.

***Puccinia moliniicola** sp. nov. (FIG. 10). Spermogoniis et aeciis ignotis. Urediis plerumque hypophyllis, subepidermalibus, sparsis, ovatis vel linearibus, usque ad 1 mm. longis, pulverulentis, pallide flavidis; urediosporis late ellipsoideis, 10–13 × 14–16 μ; membrana hyalina vel pallide flavidula, 1.5 μ crassa, minute echinulata; poris germ. obscuris. Teliis subepidermalibus, hypophyllis, rarius epiphyllis et caulicolis, sparsis, rotundatis vel oblongis, 0.3–2.0 mm. longis, pulvinatis, atro-brunneis; teliosporis (FIG. 10) ellipsoideis, utrinque rotundatis, medio non vel vix constrictis, 12–17 × 26–38 μ; membrana 1.5–2 μ crassa, ad apicem 3–5 μ crassa, castaneo-brunnea, levi; poris germ. superioribus apicalibus, inferioribus juxta septum dispositis; pedicello hyalino, crassotunicato, persistenti, 3–4 μ lato et usque ad 65 μ longo.

On *Molinia* sp.: ANHWEI: Chiu Hua Shan, Ch'ing Yang Hsien, Nov. 6, 1932, *S. Y. Cheo 1484* (type!).

This species differs from others which parasitize *Molinia* because of the small urediospores.

PUCCINIA HORDEI Otth. On *Hordeum* sp.: KWANGSI: Ling Hsien, Mar. 1933, (*1765*).

PUCCINIA RUBIGO-VERA (DC.) Wint. On *Anemone* sp.: KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1755*).

*PUCCINIA PYGMAEA Erikss. On *Calamagrostis arundinacea* DC.: KWEICHOW: Chiang K'ou Hsien, Sept., Oct. 1931, (*365, 655*).

PUCCINIA CORONATA Corda. On *Arundinella arundinacea* DC.: KWEICHOW: Tsunyi Hsien, Aug. 1931, (*470*), Kian Kiu Hsien, Sept. 1931, (*470*). On *Arundinella* sp.: KWEICHOW: Chiang K'ou

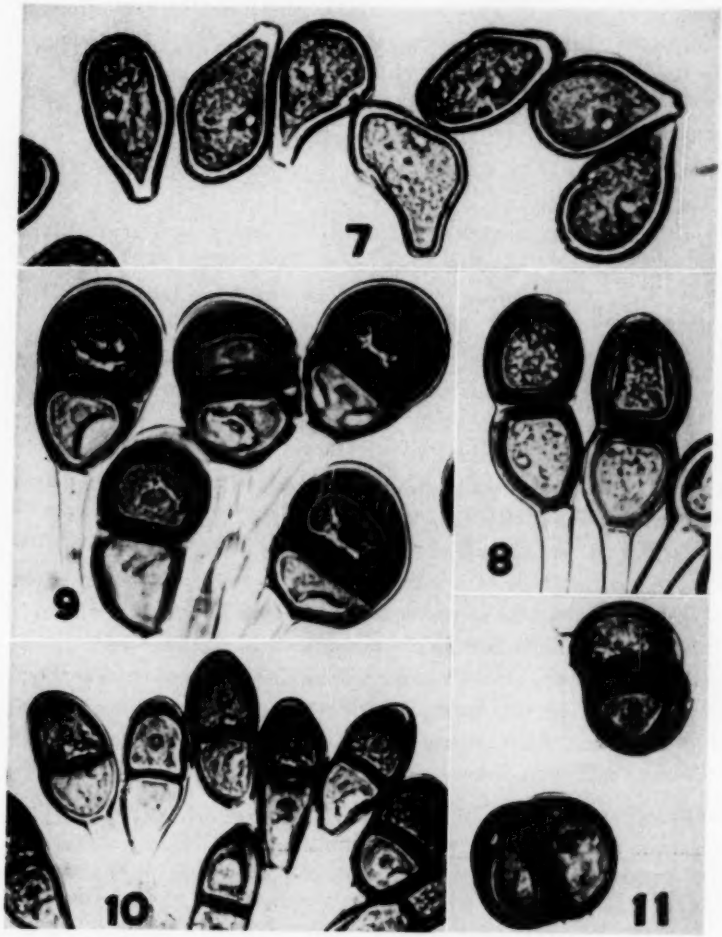


FIG. 7. Amphispores of *Puccinia anhweiana* Cumm. on *Orchis* (type); FIG. 8. Teliospores of *Puccinia longinqua* Cumm. on *Phragmites* (type); FIG. 9. Teliospores of *Puccinia morigera* Cumm. on *Eragrostis* (type); FIG. 10. Teliospores of *Puccinia moliniicola* Cumm. on *Molinia* (type); FIG. 11. Teliospores of *Puccinia pangasinensis* Syd. on *Panicum* (*Cheo 2920*). × 800.

Hsien, Aug., Sept. 1931, (*415, 450*). On *Berchemia* sp.: KWEICHOW: Tsunyi Hsien, Aug. 1931, (*286*). On *Bromus* sp.: KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1738*). On *Calamagrostis arundinacea* DC.: ANHWEI: Chiu Hua Shan, Sept., Oct. 1932, (*1357, 1452*). On *Calamagrostis* sp.: ANHWEI: Chiu Hua Shan, Oct. 1932, (*1275*); KWANGSI: San Kiang Hsien, Sept. 1933, (*2843*). On *Rhamnus* sp.: KWANGSI: Ling Yuin Hsien, Apr. 1933, (*1804*).

PUCCINIA RANGIFERINA S. Ito. On *Calamagrostis arundinacea* DC.: ANHWEI: Chiu Hua Shan, Sept., Oct. 1932, (*1330, 1357 bis, 1452 bis*). On *Calamagrostis* sp.: ANHWEI: Chiu Hua Shan, Oct. 1932, (*1275 bis*).

The sori are mainly on the sheaths and, as indicated by the numbers, occur on many of the same plants as *P. coronata*.

*PUCCINIA OAHUENSIS E. & E. On *Digitaria* sp.: KWANGSI: Yung Hsien, Oct. 1933, (*2886*).

*PUCCINIA PANGASINENSIS Syd. (FIG. 11). On *Panicum* sp.: KWANGSI: Yung Hsien, Oct. 1933, (*2920*).

This rust was described (see Cummins, Annal. Mycol. **35**: 99. 1937) on the basis of uredia collected on *Panicum carinatum* in the Philippines. As to uredia *P. taiwaniana* Hirats. f. & Hash. is also similar. The host of *P. taiwaniana* is *Panicum patens* var. *latifolium*. Cheo's number, with deep chestnut-brown teliospores, can scarcely be the same since the spores of *P. taiwaniana* are described as "flavo-brunneis." A description of the telia of the Chinese collection follows:

Telia hypophyllous, subepidermal, early erumpent, blackish brown, round or oval, 0.1–0.4 mm. diam.; teliospores (FIG. 11) ellipsoid or oblong-ellipsoid and mostly diorchidioid, rounded at both ends, only very slightly constricted at the septum, 18–25 × 26–33 μ; wall deep chestnut-brown, usually with a low and slightly paler umbo over each pore, 1.5–2.5 μ thick at sides, 3–5 μ thick over pores, smooth; pedicel hyaline, thin-walled, to 60 μ in length, persistent.

*PUCCINIA AESTIVALIS Diet.? On *Arthraxon lanceolatum* Hochst.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1479*).

This is a fragmentary collection permitting no check on the identity of the host. The teliospores of *P. aestivalis* germinate

without overwintering but no germinating spores could be found in Cheo's collection. However, the general character of the rust indicates *P. aestivalis* as the most likely species.

*PUCCINIA RUFIPES Diet. On *Imperata cylindrica* (L.) Beauv.: KWANGSI: Yung Hsien, Aug. 1933, (*2460*).

PUCCINIA ERYTHROPUS Diet. On *Miscanthus sinensis* Anders.: KWEICHOW: Kiang Kuo Hsien, Sept. 1931, (*585*). On *Miscanthus* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1122, 1272, 1415*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*919*); KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1699*), San Kiang Hsien, Oct. 1933, (*2930*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*576*).

PUCCINIA EULALIAE Barcl. On *Miscanthus* sp.: ANHWEI: Ch'ing Yang Hsien, Oct., Nov., (*1402, 1403, 1473*); KIANGSI: Hsing Tzu Hsien, Sept. 1932, (*946*); KWANGSI: Yung Hsien, Aug. 1933, (*2521*); KWEICHOW: Tsunyi Hsien, July, Aug. 1931, (*179, 210*), Chiang K'ou Hsien, Sept. 1931, (*466*).

Numbers 1402 and 1403 were originally labelled as *Saccharum* while No. 210 was *Arundinella*. The rust is certainly *P. eulaliae* and the hosts probably all *Miscanthus*.

PUCCINIA CACAO McAlp. On *Rottboellia* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2084*), Yung Hsien, Aug. 1933, (*2415*).

PUCCINIA KUEHNII (Krug.) Butl. On *Saccharum* sp.: KWANGSI: Yung Hsien, Aug. 1933, (*2444*).

PUCCINIA SORGHI Schw. On *Zea mays* L.: KWANGSI: Ling Yuin Hsien, June 1933, (*2202*).

*MIYAGIA ANAPHALIDIS Miyabe? On *Anaphalis* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2164*).

This collection may be incorrectly placed since the peridial cells attain a length of 75 μ as against published measurements of 35–50 μ in length. No material is available for comparison and only aecia are present in Cheo's collection.

***Caeoma cheoanum** sp. nov. Spermogoniis epiphyllis, subepidermalibus, 100–200 μ altis, 210–300 μ latis, eparaphysatis. Aeciis hypophyllis vel caulicolis, subepidermalibus, usque ad 8 mm. diam., flavidis; aeciosporis variabilibus, ellipsoideis vel oblongis, 18–27 × 25–52 μ; membrana hyalina vel pallide flavida, 3–4 μ crassa, verrucosa, poris germ. obscuris, verissimiliter 3–5, superequatorialibus.

On *Rubus* sp.: KWANGSI: Lao Shan, Ling Yuin Hsien, Apr. 7, 1933, *S. Y. Cheo 1824* (type!).

This species is characteristic because of its large thick-walled spores and prominent intercalary cells. Because of the host one would expect the telial stage to belong in *Phragmidium* or a related genus but the subepidermal position of the spermogonia is not typical of such genera.

AECIDIUM sp. On *Benzoin* sp.: KWEICHOW: Chiang K'ou Hsien, Oct. 1931, (*630*).

Although this is probably an undescribed species the material is too scanty to justify formal naming.

Spermogonia epiphyllous, subepidermal, globoid, 95–120 μ diam., paraphysate. Aecia hypophyllous, subepidermal, closely grouped in small, gall-like thickenings 1–3 mm. diam., short cylindric, whitish; peridial cells abutted, polyhedral, 22–27 × 29–40 μ; the wall verrucose on the inner surface, more or less uniformly 5–9 μ thick, hyaline or pale yellowish; aeciospores globoid, 18–26 × 21–26 μ; wall 1.5–2 μ thick, moderately rugose-verrucose, pale yellowish to hyaline.

*AECIDIUM QUINTUM Syd. On *Elaeagnus lanceolata* Warb. subsp. *grandifolia* Serv.: KWEICHOW: Tsunyi Hsien, Aug. 1931, (*248*).

*AECIDIUM GIRARDINIAE Syd. On *Girardinia* sp.: KWANGSI: Ling Huin Hsien, Apr. 1933, (*1954*).

A. girardiniae has the general characteristics of the aecia of *Puccinia caricis* and may prove to belong in the life cycle of that species, which has been recorded for China.

AECIDIUM POLYGONI-CUSPIDATAE Diet. On *Polygonum* sp.: KWANGSI: Yung Hsien, Aug. 1933, (*2414*).

AECIDIUM FRAXINI-BUNGEANAE Diet. On *Fraxinus* sp.: KWANGSI: Ling Yuin Hsien, May 1933, Yung Hsien, Aug. 1933, (*2179, 2304*).

AECIDIUM KLUGKISTIANUM Diet. On *Ligustrum ibota* Sieb.: ANHWEI: Ch'ing Yang Hsien, Nov. 1932, (*1515*).

***Aecidium ligustricola** sp. nov. Spermogoniis epiphyllis, subepidermalibus, globoideis, 115–140 μ diam., paraphysatis. Aeciis hypophyllis, in maculis flavidis usque ad 1.5 cm. laxe aggregatis, cupulatis, 175–225 μ, diam., pallide flavidis, lenissime recurvatis; cellulis peridii plus minusve oblongis, 13–20 ×

20–30 μ, firme conjunctis, pariete exteriore striato 4–5 μ cr., interiore labyrinthiformiter rugoso 2.5–3 μ cr.; aeciosporis globoideis vel ellipsoideis, 14–21 × 19–26 μ; membrana hyalina vel pallide flavidula, 2 μ crassa, ad apicem 6–9 μ, denseque verrucosa.

On *Ligustrum* sp.: KWANGSI: Loh Hoh Tsuen, Ling Yuin Hsien, June 12, 1933, *S. Y. Cheo 2238* (type!).

The spores with apically thickened walls distinguish this rust from other species of *Aecidium* on *Ligustrum*.

AECIDIUM FOETIDUM Diet. On *Mazus* sp.: KWANGSI: Ling Yuin Hsien, Mar. 1933, (*1670*).

*AECIDIUM sp. On *Eupatorium* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2001*).

This *Aecidium* appears to be undescribed but the material is too scanty for naming. The rust has the following characteristics: Infections causing brownish, somewhat hypertrophied areas along the veins of leaves or fusiform galls up to 4 mm. diam. and 2 cm. long on the stems; spermogonia amphigenous, globoid, 100–150 μ diam. paraphysate; aecia bullate, hemispheric, 0.4–0.8 mm. diam., opening first by a pore, the peridium not exserted, its cells mostly ellipsoid, loosely united, and not greatly different from the aeciospores; aeciospores variable, ellipsoid or globoid, 18–23 × 24–31 (–39) μ; wall 2.5 μ thick, strongly verrucose with irregular and somewhat deciduous warts, hyaline.

*UREDO IYOENSIS Hirats. & Yosh. On *Viola* sp.: KWANGSI: Ling Yuin Hsien, May 1933, (*2037*).

*UREDO ALPESTRIS Schroet. On *Viola* sp.: KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*405*).

***Uredo tholopsora** sp. nov. Urediis hypophyllis, subepidermalibus, dense sparsis, flavidis, minutis, rotundatis, 60–90 μ diam., pulverulentis, peridio hemisphaerico et paraphysibus peripheralibus praeditis; urediosporae solitarie natae, ellipsoideae, 10–15 × 18–23 μ; episporio hyalino 1.5–2 μ crasso, breviter echinulato; poris germ. obscuris.

On *Populus nigra* L.: KWEICHOW: Tsunyi Hsien, July 1931, (*33*), Fan Ching Shan, Chiang K'ou Hsien, Sept. 11, 1931, *S. Y. Cheo 392* (type!). On *Populus tomentosa* Hort.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2853*). On *Populus* sp.: ANHWEI: Ch'ing Yang Hsien, Oct. 1932, (*1376*).

Because of the host one would expect this rust to be a species of

Melampsora but this is doubtful because of the hyaline, cellular peridium. The peridium is like that of *Pucciniastrum* but in addition to the peridium there are also peripheral capitate paraphyses just inside of the peridium. These paraphyses measure 10–16 × 30–45 μ, are hyaline, and with the apical wall 6–14 μ in thickness. The sori open first by a pore but the peridium is ultimately displaced, although the sori remain small. Telia will be necessary before the relationships of this rust can be determined.

UREDO sp. On *Origanum* sp.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2850*).

The material is scanty and, while one would expect the rust to be *Puccinia menthae* Pers., the spores are small and have only two germ pores.

UREDO KYLLINGAE P. Henn. On *Kyllinga brevifolia* Rottb.: KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*454*).

UREDO sp. On *Scirpus* sp.: KWANGSI: Lo Ch'en Hsien, Oct 1933, (*2879*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*589*).

This rust does not belong with any of the common rusts of *Scirpus* because of the small uredia and urediospores, the latter measuring 14–21 × 19–25 μ. The spores are cinnamon-brown, echinulate, and have two equatorial pores borne in the somewhat flattened sides of the spore. Sawada (Taiwan Agr. Res. Inst. Rept. **86**: 1943) has described, in Formosa, three species which have urediospores with the same general characteristics: *Puccinia scirpi-mucronati* (p. 69), *P. scirpi-triqueteris* (p. 69), and *Uredo scirpi-erecti* (p. 146).

UREDO ARTHRAXONIS-CILIARIS P. Henn. On *Arthraxon* sp.: KWANGSI: San Kiang Hsien, Sept. 1933, (*2864*); KWEICHOW: Chiang K'ou Hsien, Sept. 1931, (*481*).

THE ARTHUR HERBARIUM,
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION,
LAFAYETTE, INDIANA

RUSTS ON ADOXA IN ALBERTA

E. H. Moss [1]

Since there are few records of *Puccinia argentata* (Schultz) Wint. and *Puccinia Adoxae* Hedw. f. in North America, this article is written to report these rusts for Alberta, Canada, and to present the results of cultures that confirm earlier work on life-cycles. These studies were made in the years 1942–44, but have not previously been reported pending the completion of related work which now the writer has been obliged to discontinue. Gratitude is expressed to Dr. R. G. H. Cormack for making collections from some of the experiments in 1943.

FIELD OBSERVATIONS

Puccinia argentata has been recorded for Alberta (2) and for Saskatchewan (3) on *Impatiens* but, as far as the writer is aware, has not previously been reported on *Adoxa Moschatellina* L. for Canada. For the United States, Arthur (2) gives Iowa as the only location of this rust on *Adoxa*. Arthur's Alberta record of this rust on *I. pallida* Nutt. is probably based on the writer's collection of 1932 at Lesser Slave Lake. The host plant of this collection is now determined as *I. Noli-tangere* L. The writer has since collected uredia and telia of this rust on *I. Noli-tangere* at Edmonton and on the same host and also on *I. biflora* Walt. at Wabamun, west of Edmonton. The aecial stage of this species has been collected on *Adoxa* at Edmonton, Alta., on several occasions from 1942 onward.

Puccinia Adoxae, a microcyclic species correlated with *P. argentata*, was first found at Edmonton, Alta. in 1942 and has since been collected several times in the same region. There seems to be no previous record of this rust for Canada. Collections of *P. adoxae* and *P. argentata* have been placed in the herbaria of the

[1] Professor of Botany, University of Alberta, Edmonton, Canada.

University of Alberta and the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa.

Both of these rust species occurred on *Adoxa* in an area where *I. Noli-tangere* also grew, a moist bank on the wooded north-facing slope of the river valley at Edmonton. The pycnia and aecia of *P. argentata* appeared on the leaves and flowers of *Adoxa* in early June. The telia of *P. Adoxae* developed on the same host, also early in June. Both rusts were found in close proximity, occasionally even on the same host leaf. Uredia and telia of *P. argentata* made an appearance on *Impatiens* before the end of July and became abundant during August. Careful examination of the rusts on *Adoxa* revealed no uredia and indeed no other indication of the presence of *Puccinia albescens* Plowr., a species recognized by Grove (**4**) and others on *Adoxa*, and of interest as a possible transition type between the other species on this host.

Elsewhere at Edmonton rust-free patches of *Adoxa* and of *Impatiens* were located. These furnished suitable host plants for experiments on the life-cycles of the rusts.

CULTURES OF PUCCINIA ADOXAE

Telial material of *P. Adoxae* collected from *Adoxa* plants on June 4, 1942, and stored in a refrigerator for about three weeks, was laid among rust-free *Adoxa* plants transplanted to a flat in a sheltered garden. A similar culture was started with telial inoculum collected on June 30 and placed at once among *Adoxa* transplants. In both of these cultures telia appeared on the infected plants between June 7 and July 8 of the following year, most of the pustules developing about June 15. The telia developed on the flowers as well as on leaves, many of the latter exhibiting marked hypertrophy. There was no evidence of pycnia, aecia or uredia, thus excluding the possibility of *P. albescens*, and also supporting the conclusion, based on earlier studies, that *P. Adoxae* is a microcyclic species, with typical telia but lacking pycnia. *P. Adoxae* is said to be systemic but not perennial in *Adoxa*, a view supported by the observation of the present experiments that no rust pustules were found the following year (1944) on the *Adoxa* plants, which incidentally appeared in vigorous condition. Reinfection through

over-wintered teliospores in the flats actually was expected, though most of the rusted leaves had been removed as they appeared the previous season.

CULTURES OF PUCCINIA ARGENTATA

Uredial material of *P. argentata* collected August 18 on *I. Noli-tangere* was used to infect rust-free plants of this host grown in pots and flats in the laboratory. The inoculum was applied to moist leaves and also suspended over the host plants which were covered for two days with a bell jar. Urediospores appeared 11 to 15 days later, followed very shortly by teliospores. The pustules appeared first to produce urediospores, followed closely by a dense mass of teliospores, the former being elevated by the latter. These sori appeared on the lower sides only of the leaves and showed no evidence of being amphigenous (as described by Arthur) in these experiments or in any of the local field collections of this rust.

Telial material of *P. argentata,* collected on *I. Noli-tangere,* Aug. 18, was used to carry the rust to *Adoxa.* This inoculum was placed among *Adoxa* plants of a rust-free area in the woods on Aug. 18, 1942. When the area was examined on July 1, 1943, two plants bore pycnia and aecia of the fungus. A similar experiment was set up using *Adoxa* plants in flats in a garden, the telial material applied to the basal parts of the plants which were protected by a wire screen during the winter. Pycnia and aecia appeared during a period of about five weeks, commencing June 1, 1943, the height of sporulation being mid-June. This particular plantation of *Adoxa* was maintained in good growth during 1944, but no rust pustules appeared, an observation confirming Arthur's conclusion (2) that although the aecia are systemic, the mycelium is not perennial.

Similar cultures of *P. argentata* were initiated on September 16, 1943, when teliospores from *Impatiens* were carried to garden transplants of *Adoxa.* The latter developed pycnia and aecia during the following May, much earlier in the spring than they appeared in the former cultures, a difference probably to be explained in terms of seasonal and location differences. Adjoining the flats of rust-bearing *Adoxa,* plants of *I. Noli-tangere* were grown from

seed secured the previous season at a rust-free patch of this species. Leaves of *Adoxa* bearing open aecia were transferred to the young *Impatiens* plants under appropriate conditions for infection. Uredia and telia appeared on these plants between June 10 and July 1. Thus the life-cycle of *P. argentata* was carried through, from teliospore to teliospore, under controlled conditions. This confirms the work of Arthur (1), who carried the rust from *Adoxa* to *I. pallida* Nutt., and the European work of Bubák, recorded by Arthur (2), in which reciprocal cultures were made.

LITERATURE CITED

1. **Arthur, J. C.** 1912. Cultures of Uredineae in 1910. Mycologia **4**: 7–133.
2. **Arthur, J. C.,** *et al.* 1929. The plant rusts (Uredinales). v + 466 pp John Wiley & Sons, New York.
3. **Bisby, G. R.,** *et al.* 1938. The fungi of Manitoba and Saskatchewan. 189 pp. Publ. Nat. Res. Council, Ottawa, Canada.
4. **Grove, W. B.** 1913. The British rust fungi (Uredinales). xi + 412 pp. University Press. Cambridge.

SPECIES OF SYNCHYTRIUM IN LOUISIANA. VI. TWO NEW SPECIES ON IMPATIENS AND SMILAX

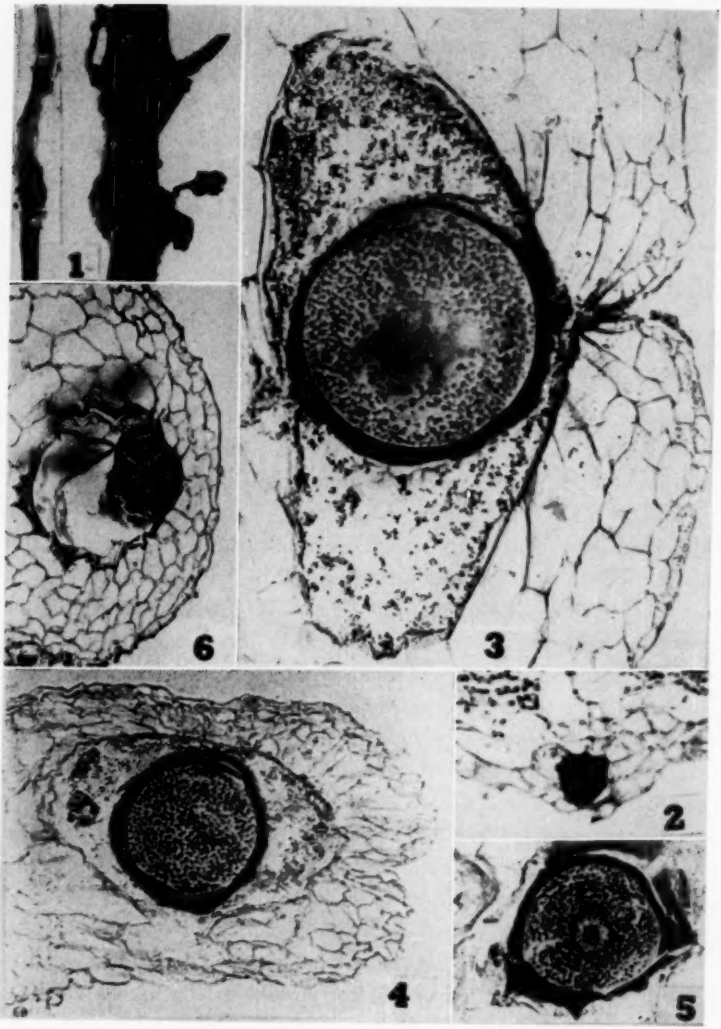
MELVILLE T. COOK

(WITH 12 FIGURES)

Synchytrium Impatientis sp. nov.

The galls are found on stems, petioles and leaves of *Impatiens pallida* Nutt. and *I. biflora* Walt. They are most abundant at base of plant, often closely crowded and sometimes one on another (FIG. 1). They occur on any part of the stem but are usually most abundant just below the nodes, especially near the base of the plant. When abundant they cause swellings of the infected parts and a dwarfing of the plants. They are few and scattered on petioles and leaves.

The infections occur on small, young plants growing in low lands that are flooded for short periods in the late winter or early spring. The zoospores penetrate the epidermal cells when very young and before there is any differentiation into palisade and mesophyll tissues. The galls are variable in size and shape. Those on the stems range from hemispherical to elongated. Those on the leaves and petioles are usually smaller than those on the stems and those on the leaves are mostly on the under surface and spherical or nearly spherical. They are composed mostly of very loose mesophyll tissue. Those on the stems range from 320×400 to $560 \times 960\,\mu$. Those on the leaves range from 480×480 to $700 \times 800\,\mu$. They vary from green to pink and are composed of parenchyma tissue. The epidermal cells are small. The cavities in the galls vary in size and shape. They are formed by the enlargement of the infected epidermal cells which become covered by growths of the surrounding cells. The opening to the cavity (infected cell) closes but is distinct (FIG. 3). The cavity may become spherical



FIGS. 1–6. *Synchytrium Impatientis.* 1. Stems of *Impatiens* showing galls. 2. Young gall on lower side of leaf, the fungus covered by a single layer of epidermal host cells. 3. A very large gall on stem showing fungus surrounded by granular contents of host cell. 4. Fungus enlarged, infected host cell and host cell nucleus. 5. Fungus showing nucleus. The cell contents are solid. 6. Numerous sporangia.

or elongated in shape. The walls of the cells lining the cavity are not thickened.

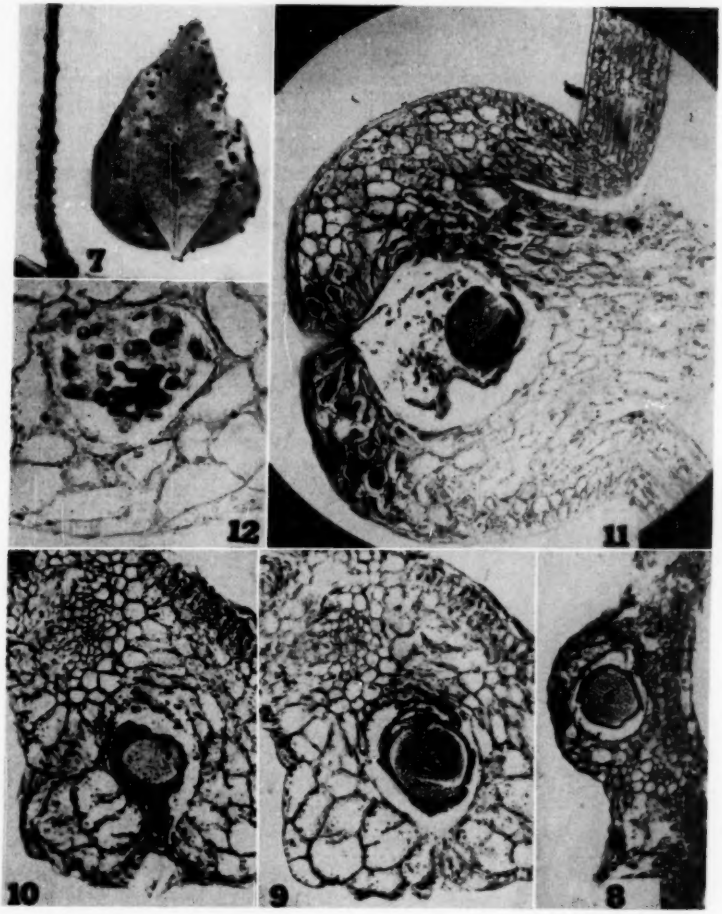
The fungus is variable in size, spherical in shape and attains a size of 320 μ in diameter (FIGS. 2–5). It is surrounded by a granular material (FIGS. 3, 4) which may become compact and hard (FIG. 5). The nuclei are very small and were seen in only a few cases (FIG. 5). The wall around the fungus develops early, is thick and appears to be composed of three layers. The size of the fungus is not correlated with its age, but with the size of the gall. It is light lemon yellow when young, becoming yellow, orange, and dark orange with age. The fungus grows rapidly and almost completely fills the cavity but is surrounded by a granular or compact mass (FIGS. 3, 5). The host cell nucleus was observed in a few cases (FIG. 4). The fungus grows less rapidly than the gall and may be only ¼ full size when the gall is full size. The sporangia are angular, granular and about 64 μ in diameter.

Gallis forma magnitudineque variis, hemisphaericis vel elongatis, in stirpibus, petiolis et foliis sitis, in stirpibus 320 × 400 μ ad 560 × 960 μ, minoribus gallis in petiolis; in foliis 480 × 480 ad 700 × 800 μ. Fungus sphaericus magnitudine varius, circa 320 μ diametro, juventute sublimoniflavus, se in colorem flavum, luteum atque nigrum aetate mutans, parietibus crassis, sporangiis 64 μ diametro.

Hab. *Impatiens pallida* Nutt. and *I. biflora* Walt. Baton Rouge, Louisiana, U. S. A.

Synchytrium Smilacis sp. nov.

The galls occur on *Smilax* spp. They may be abundant and crowded or scattered on stems and petioles (FIG. 7); less abundant and scattered or crowded on leaves (FIG. 7). They are large and spherical, especially on stems. They have a pit at top and a short stem at the base. The galls on the leaves occur on either the upper or lower surface, usually the lower and in a pit. They may project on one or both surfaces of the leaves. When cut through the center at right angles to surface of gall stem or leaf the section appears as two wings separated by a notch. The bases of the leaf galls are usually embedded in the tissues of the leaf and the normal structure of the leaf at that point is lost. The galls are very uniform in size, about 640 × 640 μ and composed of large parenchyma



FIGS. 7–12. *Synchytrium Smilacis.* 7. The galls on leaf and petiole. 8. A young gall showing fungus with nucleus. 9. A slightly older gall. 10. A gall about same age as 9. 11. Section through a very large leaf gall. The fungus is young and does not fill the cavity. 12. Sporangia.

cells. The infections occur on very young plants growing in wet regions that are flooded for short periods in the late winter or early spring. The infections are in the epidermal cells before there is any differentiation into palisade and mesophyll. The cavity, which is formed from the infected cell, is usually spherical but may be

slightly pear-shaped (FIGS. 8–11). The host cell contents are granular, sometimes becoming compact.

The fungus grows slowly and rarely fills the host cell completely. The host cell nucleus was seen in a few cases. The fungus is $80 \times 100\,\mu$. The sporangia are about $16\,\mu$ in diameter.

Gallis in stirpibus, petiolis et foliis, sphaericis in fovea aliquando sitis atque fovea in summis gallis, $640 \times 640\,\mu$. Fungus $80 \times 100\,\mu$; sporangia $16\,\mu$ diametro.

Hab. *Smilax* spp. Baton Rouge, Louisiana, U. S. A.

The author wishes to express his thanks to Dr. C. W. Edgerton for suggestions and for making the photographs, to Dr. P. J. Moorehead, who translated the descriptions, and to graduate students who aided in the collection of the material.

DEPARTMENT OF BOTANY,
LOUISIANA STATE UNIVERSITY,
BATON ROUGE, LOUISIANA

BOOK REVIEWS

MORPHOLOGY AND TAXONOMY OF FUNGI, by Ernst Athearn Bessey. Pp. i–xii, 1–791. Philadelphia: The Blakiston Company, 1950. Price, $7.00.

Bessey's *Textbook of Mycology*, published in 1935, was a highly successful and extremely useful book. The long-awaited revision has now appeared and proves to be an entirely rewritten and much enlarged work. Appropriately, it has been given a new title, to emphasize the fact that despite its greatly increased size, it makes no pretense of treating the important and rapidly developing fields of fungal physiology and genetics and the technical application of mycology. It is highly desirable that those who work in such fields should have a knowledge of the taxonomy and morphology of the fungi as a whole and that is what the present text attempts to present. Certain of the features which made the earlier book exceptionally useful, notably the ample bibliographies and the guide to literature for the identification of fungi, have been retained and brought up to date. The number of illustrations has been substantially increased and many of the cuts used in the older text have been replaced by new and better illustrations of the same species. The imperfect fungi, in which interest has been rapidly increasing in recent years and which are given extremely perfunctory treatment in most works, are here allotted 56 pages. The lichens are regarded as fungi parasitic on algae and their place is therefore with the fungi with which their structure suggests affinity. The Lecanorales are adequately discussed but there is no mention of such common forms as *Graphis, Dermatocarpon* and the other pyrenolichens nor of the basidiolichens. The rusts and smuts are now included by the author in the Basidiomyceteae as the subclass Teliosporae, coordinate with the Heterobasidiae and Eubasidiae, instead of being treated as a distinct class. The author still uses the feminine endings for his group names, probably to stress his conviction that fungi are plants, and explicitly excludes the slime molds, but, as a concession to custom, includes, under the heading

Mycetozoa, taken in a wide sense, a discussion of the various animal-like groups involved.

The author has positive views on many controversial issues and does not hesitate to express them. He does, however, attempt to state opposing views fairly and to cite references where students may find them presented in detail. It will be a dull reader who cannot find in such discussions a challenge to further investigation.

The proof-reading has been meticulous—no easy task considering the nature of the subject-matter—and a careful reading of substantial sections has revealed no errors of that kind. A few figures are mislabelled, but the errors are not such as to cause confusion. *"Cyathus striatus,"* on p. 548, is surely *Crucibulum levis,* and *"Tremella reticulata,"* on p. 452, is not that species, but *T. foliacea.* Both figures illustrate admirably the habit of their respective groups. These are very minor faults in a book which represents the most important summary of descriptive and taxonomic mycology since the last edition of de Bary's great work. It is a credit to American mycology and to its distinguished author. —G. W. M.

PHYSIOLOGY OF FUNGI, by Lilian E. Hawker. Pp. 360. University of London Press, 1950. Price, 21 shillings.

With an increasing number of institutions offering special courses in the physiology of fungi, there has developed a rapidly-growing need for a suitable introductory textbook. This little volume of Dr. Hawker's appears to be the immediate solution to this problem. The text is presented in eight chapters bearing the following titles: (1) Introduction: typical life cycle of fungi; (2) Growth and variation; (3) Nutrition; (4) Respiration; fermentation and metabolic products; (5) The effect of nutrition on sporulation; (6) Other factors influencing growth and sporulation; (7) Factors influencing the survival and germination of spores; (8) Interaction with other organisms. Although the limited number of chapter titles may make this book appear to be limited in scope, a perusal of the various chapter sub-titles soon dispels any such idea.

In order to illustrate the various principles which she discusses, the author has selected her examples from all of the great groups

of fungi (exclusive of the Myxomycetes). Indicative of the fact that the author is concerned with the physiology of many fungi is the index to genera and species of fungi and lichens which has over four hundred entries.

For the most part this book is well-written and the meanings quite clear; however, there are a number of unfortunate choices of words, principally involving sentences where "to" should be replaced by "and"; *e.g.,* "Conversely spores are blown from cool regions *to* reinfect autumn-sown crops. . . ." The word "and" could also be used to advantage as a substitute for "so that" in such sentences as: "Thus the teeth of species of *Hydnum* are positively geotrophic, that is, they grow vertically downwards *so that* the basidiospores are shed in a manner which avoids wastage. . . ." It is doubtful if Dr. Hawker believes these sentences as they are now written and it is to be hoped that she will change them in the next edition.—WILLIAM D. GRAY.

NOTES AND BRIEF ARTICLES

Trechispora and Pellicularia

On the recommendation of the Special Committee for Fungi, the Seventh International Botanical Congress recently adopted a new version of the Rule concerning nomina confusa (the present Art. 64), which reads in part: "A name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, unless it is possible to select one of these elements as a satisfactory type of the name" (Syn. Prop. . . . Seventh Int. Bot. Congr. p. 183. 1950). Even those botanists who, like the writer, opposed the adoption of this Rule are of course under obligation to follow it.

The suggestion has been made that both *Trechispora onusta* Karst., the genotype of *Trechispora,* and *Pellicularia Koleroga* Cke., the genotype of *Pellicularia,* may be nomina confusa as defined by both the old and the new Rule. No evidence has been published that either is such in fact, and in respect to the *Trechispora* the assertion has been formally denied (Mycologia **36**: 76. 1944; Farlowia **4**: 40. 1950) after study of a fragment of the type.

In spite of this absence of evidence that either name is properly subject to the Rule quoted, it seems advisable to preclude any obligation that might arise, from future evidence or opinion, for someone to compile a new set of binomials in either genus. *T. onusta* is, therefore, hereby typified by the portion of the type specimen that gives rise to and includes the basidia illustrated in Mycologia **36**: 81, fig. 1. 1944; *P. Koleroga* is likewise typified by the portion of the type specimen that gives rise to and includes the basidia illustrated in Mo. Bot. Gard. Ann. **5**: 124, fig. 1a. 1918; **13**: 293, fig. 1a. 1926. Since both types are completely fertile, both are as "satisfactory" as any rule could require.—Donald P. Rogers.

THE GENUS SEISMOSARCA COOKE

The genus *Seismosarca* was based by Cooke (Grevillea **18**: 25. 1889) on a fungus collected in New South Wales. Shortly thereafter he illustrated the microscopic characters (Handb. Austral. Fungi, *pl. 12, f. 94*). The gross characters are described as "Inflated, gelatinous, lobate (2–3 in. diam.) dingy pale fuliginous, very soft and watery. . . ." Description and illustration agree that the basidia are clavate and unseptate and that the spores are elliptical and bright brown. In the first publication Cooke makes no reference to the position of the genus with reference to other genera; in the Handbook, however, he lists the genus (p. 208) between *Tremella* and *Dacrymyces,* obviously on the basis of its gelatinous consistency. Lloyd (Letter **62**: 6. 1916; Myc. Writ. **5**: 629. 1917) examined the type at Kew and reported that the basidia were of the tremellaceous (cruciate-septate) type, that the hairs described by Cooke were gloeocystidia, that the spores described by Cooke were in reality those of a *Coniophora* and that the real spores were pale yellow and larger, $12 \times 6\,\mu$. He added that Cooke's species was congeneric with the common American tremellaceous fungus previously called *Exidiopsis alba* Lloyd (Letter **44**: 8. 1913), which he transferred to *Seismosarca* and which Burt (Ann. Missouri Bot. Garden **8**: 366. 1921) later transferred to *Exidia.* There is a very common, soft, gloeocystidiate tremellaceous fungus in Australasia and in tropical America which clearly seems to be the species identified by Lloyd with Cooke's species. Neither it nor *S. alba* is entirely at home in *Exidia* or *Tremella* and I have, therefore, been following Lloyd in referring both to *Seismosarca,* chiefly on the basis of the possession of gloeocystidia. This, in itself, is not too satisfactory, since the two species differ in other respects, especially in the relatively firm, almost subfleshy consistency of *S. alba* and the extremely soft and deliquescent character of the collections referred to *S. hydrophora.*

Recently, I had opportunity to examine the type of *S. hydrophora* at Kew and to remove a portion for microscopic study. The specimen at present is dark, thin, and firmly attached by the abhymenial surface to the paper on which it is mounted. There is now little suggestion that it was substantially inflated or would

have been deliquescent when mature. In general appearance, it suggests an *Auricularia* and a thin section through the pileus confirms this opinion. The hymenium is extremely tough and the basidia are not clear, but so far as I could judge, after mounting sections in various reagents, they are long, narrow and transversely septate. Mr. B. Lowy, who is making a special study of *Auricularia,* confirms my opinion and suggests that the specimen may be referable to *A. tenuis* (Lév.) Farlow. The bright yellow spores described by Berkeley are present, and I can confirm Lloyd's statement that they are *Coniophora*-type spores which happen to have fallen on the *Seismoscarca,* but I am at a loss to explain his reference to "Basidia of the typical *Tremella* form." At any rate, I am convinced the fungus is not a member of the Tremellaceae and that the genus should be discarded.

The two best-known species which have been referred to this genus have perfectly good names which may be used pending a revision of the tremellaceous genera. *S. alba* may be included in *Exidia* as *E. alba* (Lloyd) Burt, where its gloeocystidia and firm texture will readily separate it from other species; *S. hydrophora* may be referred to *Tremella* as *T. pululahuana* Pat. (Bull. Soc. Myc. Fr. **9**: 138. 1893), where again the conspicuous colored gloeocystidia will separate it from other Tremellas and the very soft, gelatinous, lobate basidiocarp from *Sebacina,* Sect. *Bourdotia.*

Two other species have been described in recent years, *S. stratosa* Viegas (Bragantia **5**: 243. 1945), from Brazil, and *S. tomentosa* Olive (Mycologia **39**: 99. 1947), from Georgia. The disposition of these must await examination of authentic material.—G. W. MARTIN.

PERONOSPORA STIGMATICOLA IN CANADA[1]

Dr. C. Frankton recently drew the writer's attention to a fungus on the stigmas and occasionally on the filaments of a specimen of *Mentha arvensis* var. *villosa* from Queens Co., P.E.I. (I. J. Bassett *1590,* 5 Aug. 1950). The fungus proved to be *Peronospora stig-*

[1] Contribution No. 1055 from the Division of Botany and Plant Pathology, Science Service, Ottawa, Canada.

maticola Raunkiaer. The unusually long spores, about 25–47 × 11–15 μ, and the exceptional habitat precluded any doubt as to the identity. *P. stigmaticola* occurs in Europe on *Mentha arvensis* and *M. aquatica* in Denmark, Russia and Sweden, according to Gäumann,[2] but there seems to be no record of its occurrence in North America. The growth on the filaments is generally sparse and inconspicuous, but the conidiophores form dense tufts on the stigmas and are readily seen under a powerful hand lens. All the specimens of *Mentha arvensis* in the phanerogamic herbarium of this Division were scrutinized and the fungus was found on a single collection of *M. arvensis* var. *villosa* f. *glabrata* from Brant Co., Ont. (W. H. Minshall *3905*, 2 Sept. 1947). It is suggested that a search of other herbaria may yield further specimens.—D. B. O. SAVILE.

DERMATEA VS. DERMEA

It was pointed out by Seaver and Velasquez (Mycologia **25**: 139–149. 1933) that according to the International Rules it was necessary to adopt the spelling *Dermea* for this genus. As the Rules then stood, this was correct, but as a result of the changes in Article 20 adopted at the VII International Botanical Congress, Stockholm, *Dermatea* becomes the correct spelling. The Elenchus Fungorum has been officially declared to be a part of the Systema Mycologicum, and the nomenclatorial status of names published in the Systema is not to be affected by names published previously elsewhere. The genus was published as *Dermea* in the Systema Orbis Vegetabilium in 1825, and as *Dermatea* in the Elenchus in 1828. *Dermatea* is, therefore, correct. Following previous usage (Mycologia **38**: 351–431. 1946) I regard these two names as orthographic variants not requiring new combinations.—J. WALTON GROVES.

[2] E. Gäumann. Beiträge zu einer Monographie der Gattung *Peronospora* Corda. Zürich. 1923.

LABORATORY TRAINING COURSES

A series of laboratory training courses is offered by the United States Public Health Service at the Communicable Disease Center, Chamblee, Georgia, throughout 1951. The courses will last from one to four weeks. Of particular interest to mycologists are Laboratory Diagnosis of Mycotic Diseases (May 14–18 and October 29–November 2), for directors, and two general courses under the same title, Part 1, Cutaneous and Subcutaneous Fungi (April 16–27; November 5–16) and Part 2, Systemic Fungi (April 30–May 11; November 19–30).

Information and application forms should be requested from the Officer in Charge, Laboratory Training Services, Communicable Disease Center, P. O. Box 185, Chamblee, Georgia.

Correction

In the paper by Sprague & Johnson, *Ascochyta* leaf spots, Mycologia **42**: 523–553. 1950, it should have been noted that all figures were reproduced at a magnification of × 1000.

Note to Authors

The charges for reprints of articles published in Mycologia have remained unchanged since September, 1923. Even many years ago these charges were reasonable, and for a number of years they have been much below those of other journals. The Lancaster Press has proposed a new schedule of prices, based on their increased costs, and embodying increases of about 58% over the 1923 schedule. These rates, which have been accepted and are printed on the inside back cover of this number, apply to all papers for which manuscript is received by the Editor after February 28th.

MANUSCRIPT

Publication in MYCOLOGIA is restricted to members of the Mycological Society of America. The Board reserves the right to alter this regulation should circumstances warrant. When a paper has two or more authors, the person submitting the paper is expected to comply with this requirement.

Papers should be submitted in duplicate to the Editor-in-Chief or to any member of the Editorial Board. Papers will be published in the approximate order of their approval except for the address of the retiring President, which will be published when received, and papers whose cost of publication is paid by the authors, which will be run at excess pagination. Notes, Brief Articles and Reviews may be used at the discretion of the Editor-in-Chief.

All illustrations will be treated as figures. Authors are requested to number their figures consecutively throughout the paper, using letters for subdivisions, as: Fig. 1, a; Fig. 2, c. Full-page figures should be made so that, when reduced, the width will not exceed 4 inches, and should be short enough to permit the insertion of a legend below the figures. Each article will be restricted to twenty-five pages, including illustrations, except when authors submit only one paper in two or three years of membership, in which case the restriction will be forty and fifty pages respectively. Ruled tabular matter is counted double. Should an author wish to publish additional pages in one article he may do so by paying for the excess pages at current rates.

Each author will be restricted to two pages of half-tone illustrations for each article, or their equivalent (the cost of each being approximately $9.25). Should the author submit illustrations for which the cost of cuts exceeds that amount, he will be asked to bear the excess cost of the cuts in addition to excess pages.

To comply with the International Rules, it is recommended that contributors furnish *brief* Latin diagnoses of all new species and genera when their manuscript is submitted for publication.

PRICE LIST OF REPRINTS

	4pp. 1 to 4	8pp. 5 to 8	12pp. 9 to 12	16pp. 13 to 16	20pp. 17 to 20	24pp. 21 to 24	28pp. 25 to 28	32pp. 29 to 32
50 Copies . . .	$3.93	$6.28	$9.81	$10.21	$13.35	$15.31	$17.66	$18.84
100 Copies . .	4.71	7.46	11.38	12.56	16.09	18.84	21.98	23.55
Additional Copies per C. .	1.57	2.36	3.93	4.71	5.90	7.07	8.64	9.42

For 500 copies deduct 5%; for 1000 copies or more deduct 10%.

Covers: For first 50 covers, $6.30; additional $3.10 per C.

For more than 32 pages add cost per schedule to make total. Example: for 44 pages add cost for 32 pages and 12 pages.

Note: For any reprints requiring additional composition or changes, either in text or cover, an extra charge will be made.

LANCASTER PRESS, INC.
LANCASTER, PA.

Partial List of Publications of The New York Botanical Garden

Mycologia, bimonthly, illustrated in color and otherwise; devoted to fungi, including lichens, containing technical articles and news and notes of general interest. $7.00 a year; single copies $1.50 each. Now in its forty-second volume.

Established by The New York Botanical Garden in 1909, in continuation of the Journal of Mycology, founded by W. A. Kellerman, J. B. Ellis, and B. M. Everhart in 1885. Edited by William Alphonso Murrill 1909–1924. Edited by Fred Jay Seaver 1924–1946; by Alexander H. Smith 1946—. Beginning with January, 1933, it was adopted as the official organ of the Mycological Society of America.

Journal of The New York Botanical Garden, monthly, illustrated, containing news, book reviews, and non-technical articles on botany, exploration, and horticulture. Free to all members of the Garden. To others, 15 cents a copy; $1.50 a year. Now in its fifty-first volume.

Addisonia, devoted exclusively to colored plates accompanied by popular descriptions of flowering plants; eight plates in each number, thirty-two in each volume. Published irregularly. Free to all members of the Garden. Subscription price, $10.00 per volume. Now in its twenty-second volume.

North American Flora. Descriptions of the wild plants of North America, including Greenland, the West Indies, and Central America. Planned to be completed in 34 volumes. Roy. 8vo. Each volume to consist of four or more parts. [Not offered in exchange.] Volumes 1–10 devoted to fungi.

Vol. 1, part 1, 1949. Myxomycetes. $7.25.

Vol. 2, part 1, 1937. Blastocladiaceae, Monoblepharidaceae, Saprolegniaceae, Ectrogellaceae, Leptomitaceae. $2.00.

Vol. 3, part 1, 1910. Nectriaceae—Fimetariaceae. $2.00.

Vol. 6, part 1, 1922. Phyllostictaceae (pars). $2.00.

Vol. 7 (now complete), parts 1–15, 1906–1940. Ustilaginaceae—Aecidiaceae (pars). Parts 1, 2, and 3 no longer sold separately. $2.00 per part.

Vol. 9 (now complete), parts 1–7, 1907–1916. Polyporaceae—Agaricaceae (pars). $2.00 per part. Parts 1–3 no longer sold separately.

Vol. 10, part 1, 1914; parts 2 and 3, 1917; part 4, 1924; part 5, 1932. Agaricaceae (pars). $2.00 per part.

Brittonia. A series of botanical papers. Subscription price, $7.50 per volume. Now in its seventh volume.

NEW YORK BOTANICAL GARDEN
Bronx Park, New York 58, N. Y.